SCIENTIFIC AMERICAN SUPPLEMENT

Scientific American Supplement, Vol. I., No. 12.
Scientific American, established 1845.
New Series, Vol. XXXIV., No. 12.

NEW-YORK, MARCH 18, 1876.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.
Postage free to Subscribers.

FISH CULTURE.

By Greville Fennell.

It has been truthfully observed that the great merit of a discovery consists in making it useful and of benefit to mankind; and such being admitted, we leave others to contend for the honor of the first idea, and introduce Messrs. Gehin and Remy to our readers. These men were poor fishermen, living by their calling in the commune of Bresse, in the department of Vosges, France.

It was about the year 1841 they commenced to observe carefully the habits of the trout, and in the month of November of that year, during a full moon, they passed night and day on the banks of a river, never for an instant losing sight of these fish, and watching most intently all their preparations for laying and preserving their eggs. The results of their observations were these:

"The trout come together in a shoal, and choose a current with a gravelly bottom as the best place to lay their eggs. They did it in a round hole, sometimes of the depth of seven inches by three in diameter; they place in the middle of this space, parallel with the current, a line of stones, the size of which varies with the size of the fish. The female then passes over the line of stones, gliding over, rubbing against, or resting upon them. This she does again and again, some twenty or thirty times, till her eggs are all laid in the crevices of the gravel.

"When the female has done this, the male, in the same manner, by passing over and pressing upon the gravel, unites the milt, or soft roe, which covers and fecundates the eggs; then with tail, fins, head, and belly, he works away until he manages to cover the eggs with gravel.

"Now a second female commences, and in the same manner lays her eggs in a parallel line with and against the first row. When the fecundation is complete, which generally happens in about fifteen days, according to the number of fish, all unite in heaping up stones and gravel in mounds upon the eggs, in a manner resembling great ant-hills.

"The eggs remain in this way for a month or two; at the end of that time, which M. Gehin could not precisely determine, the little fish appear about the size of pins, come out of their cell, between the interstices of the gravel, and seek in the tranquil waters near the shores a place of safety.

"Having thus got an insight into Nature's secrets, it remained to discover a mode of rendering them practically useful, and not until many failures did Gehin and Remy hit upon a sure process."

Artificial spawning for salmon is very simple. All that is required is to obtain as many female fish or spawners as are deemed sufficient to produce spawn enough to restore the river. Some works of pretension tell us that the males are more scarce than the females; but experience and observation teach us the remarkable fact that, amongst all salmon and trout spawning-beds, the contents of the nests will be found to contain seven cocks to one hen. This is the more to be observed in those rivers in which the weir stops the fish from ascending into the more ample and more natural, and consequently more acceptable spawning-grounds. In the pools of such weirs they crowd together, and as the fish can not hold their spawn when fully ripe, they fight and hustle each other for an appropriate place; and in this way not only are the ova scattered about, and in most instances entirely wasted, but the fish are much injured by fighting, and seldom or never, as is well known with most fish, recover even from the slightest bodily flesh wounds. Hence the great importance of salmon ladders to admit of their reaching a greater field of operations in which they may begin and finish their interesting and profitable duties without hindrance or molestation.

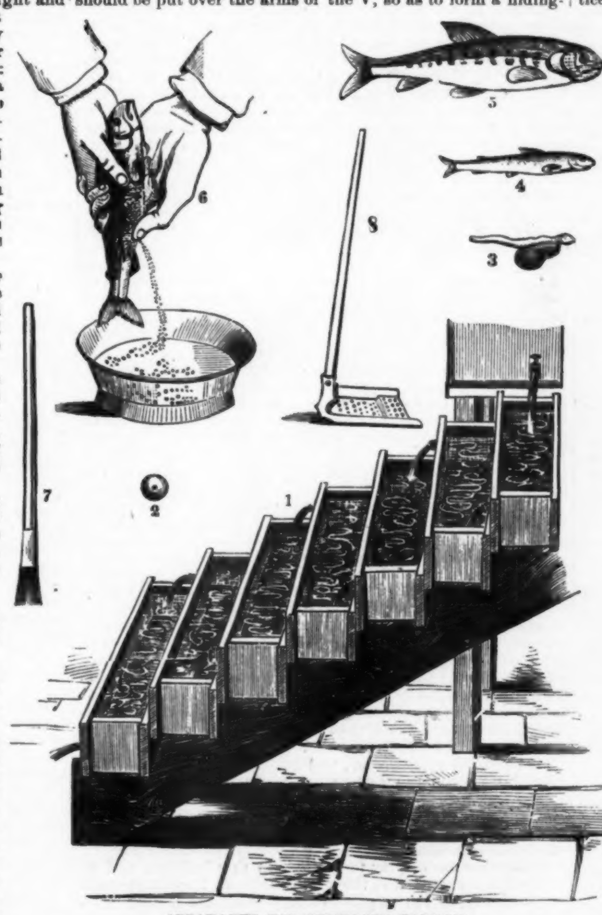
The principal thing to attend to is to take the female at the right time; and this is when she is working high up stream; for though some females return nearly ready to spawn, the greater number make for the springs some time before they are full gone, and ripe for parturition. You may easily know when a fish is full up, and in condition to have her eggs taken from her, by looking out for the redness and pear-shaped protrusion of the vent; and this must be particularly attended to, or the mother may be destroyed in the operation. The small fish are the first to spawn. The larger ascend later; but it is always advisable to obtain, if possible, a young male and an old female, as the brood are always the best.

Artificially-bred salmon are always round and big-headed creatures, no matter how handsome and small-headed the parent fish were from which the ova and milt were taken.

In migrating-time the young become as wild as nightingales, and attempt to leap their barriers. To prevent injury and loss, boards, slanting inwards, should be placed so that they may fall on them and be thrown back into the water.

Mr. Buckland says the conclusions he has arrived at relative to artificial breeding of salmon are briefly as follows: "Firstly, that the plan of slate or wooden breeding-boxes, placed one above the other, and fed by a half-inch tap, is much preferable to boxes let into the ground. These boxes should contain almost one third of their depth of fine gravel; the gravel should be well washed *and boiled* before being put into the boxes. Covers of wood should be placed over the boxes to keep out the light, as *light is unfavorable* to the germination of the ova. The great advantage of these boxes is, that the eggs can be counted into them, and the young ones counted out, so that the result in the number of fish hatched can be clearly known (of course taking stock of the addled eggs removed), a matter of great uncertainty in the rough out-of-door boxes. The eggs can also be easily removed as they die off.

"Secondly. The young fish should be turned out when the umbilical bag is nearly absorbed. They should never be let free in ponds or any thing approaching stagnant water. The best plan is to put them into cans, the water of which should be kept cool during the journey with ice, and send them to the upper waters of the tributaries of the river. V-shaped weirs, directed up stream, should be built with the stones in the stream, and a large stone, slate, or covering should be put over the arms of the V, so as to form a hiding-place for the young fish. From five to ten little fish should be put into each of these artificial hiding-places. Fish thus turned out grow much faster than fish kept in any sort of captivity; they obtain of their own accord the quality of food, and the superintendence of a man to look after the nursery-ponds is saved.



APPARATUS FOR BREEDING SALMON.

Refs. to Figs.—1. Boxes for artificial salmon-rearing. 2. Egg, showing oil-globule. 3. Young fish, showing umbilical bag. 4. Young salmon after being fed from his umbilical bag. 5. Young salmon fully developed. 6. Method of taking eggs from fish. 7. Hair pencil for taking fish from eggs. 8. Small perforated shovel for lifting the fish first hatched, to transfer to the running streams or nursery.

"Thirdly. The slate rearing-troughs can be set to work in gardens, stable-yards, greenhouses (where there is no fire), or any other suitable locality under cover, where there is a cistern or other water-supply large enough to afford the requisite flow of water. The quantity flowing through a half-inch pipe day and night is quite sufficient.

"Fourthly. Natural obstructions, or even small waterfalls in private gardens, may be easily rendered available for hatching fish. When the fish come to the obstruction, they should be netted out from the pool below, their eggs taken from them, and returned to the river; the boxes being arranged by the side of the waterfall, a leaden pipe with a stopcock can be easily introduced into the water above the fall, and thus be made available for the feeding of the boxes."

The boxes, of which we give an illustration, can be readily made. The gravel should be about the size of large peas, and the proportions should be one third gravel to two thirds depth of water. The dead eggs are best removed with a wire forceps, which should be done every day. The current of water should be gradually increased. Pisciculturists differ as to the best time of turning out the fry, some being for doing so before, others at the time, and some few after the umbilical bag has been absorbed. The upper waters of natural streams, in which the depth is not more than a foot or eighteen inches, form the best nurseries for the young fry, but they should be regularly fed every evening, not in the middle of the day, as they will then refuse their food, and it will fall to the bottom and become stale. Plenty of water-weed should be placed in these nurseries, as they produce aquatic insects of which all fish are very fond, and on which they live and thrive. It is necessary to give the fish hides to go under and through in all stages after they come out of the egg. The hides can be easily made with pieces of common roofing slate supported about two inches from the bottom. The fish will invariably be found to congregate under them. The same water which runs through the boxes will do to supply the nursery, which is better out of doors than in doors. Water-cress beds are above all things most suitable for bringing up young trout.

This description of apparatus has been at work for four years at Windsor Great Park, where the best results in practice have been obtained by the stocking of the Obelisk Lake with trout.

We have mentioned the umbilical bag. This is found attached to the belly of the young fish, when it quits the egg, and is situated between the pectoral fins (Fig. 3). It contains oil-globules and albumen, and serves to nourish the fish for at least six weeks. When it is absorbed, the fish begin to feed, but not before. Often the little fish stick in the egg, and have to be helped out of it, which can be done by the delicate manipulation of a hair pencil (Fig. 7). Some trout eggs are the color of barley-sugar, and some of brown barley-sugar. After the mixture of the milt, they have a bloom come over them, like that of a peach, and they likewise become slightly adherent to the stones about them. The oil-globule in the centre of the egg can be seen from the first moment (Fig. 2). The test of a ripe egg, says Mr. Buckland, is this: put one in the mouth, and if you can crush it with the teeth it is not ripe; but if the covering of the egg feels hard and horny, and slips away from between the teeth, the egg is ripe.

After the eggs have been taken from the fish (Fig. 6) the parents will be found extremely faint, and the manipulator must be very particular in holding them for a short while with their heads up stream, and slightly raised, that they may receive the revivifying effects of the current, or they will die, and the operator receive discredit from the owner of the fishery.

[Zoologist.]

GREAT SEA SERPENT.

Captain Dewar, of the barque "Pauline," bound with coals for Her Majesty's Naval Stores at Zanzibar, when in lat. 5° 13′ 8″ S., long. 35° W., October, 1874, observed three very large sperm whales, and one of them was gripped round the body with two turns by what appeared to be a large sea serpent. Its back was of a darkish-brown and its belly white, with an immense head and mouth, the latter always open; the head and tail had a length beyond the coil of about thirty feet; its girth was about eight feet or nine feet. Using its extremities as levers, the serpent whirled its victim round and round for about fifteen minutes, and then suddenly dragged the whale down to the bottom head first. On the 13th July this or another sea serpent was again seen about two hundred yards off the stern of the vessel, shooting itself along the surface, forty feet of the body being out of the water at the same time.—*Rev. E. L. Penny, M.A., Chaplain to H.M.S. "London."* A letter received at Plymouth from J. H. Landells, the second officer of the "Pauline," says there were five whales near the ship; the largest was attacked by a serpent. The reptile coiled two complete turns round the thickest part of the whale's body, and appeared possessed of complete power over the fish. The whale, in an agony either of pain or terror, was continually throwing itself half out of the water. He considers the serpent to have been at least one hundred and fifty feet in length.

[There can be no hesitation in explaining this narrative, if true, to have reference to a gigantic cephalopod: it would be a marvellous instance of just retribution, for the whales feed on cephalopods, if the cephalopods every now and then devour a whale by way of retaliation.—*E. Newman.*]

THE LIMITS OF MICROSCOPIC POWER.

Professor Abbe, of Jena, asserts that the limit of a microscope, in showing the structure of the tissues and the character of minute objects, has now been nearly, if not entirely, reached—higher power than at present in use giving rise to optical phenomena which are likely to completely mask the structure and nature of the object under examination. These observations apply more especially to the marking of certain diatoms and striated muscular fibre. According, however, to the results arrived at by Professor Abbe, after prolonged and very careful investigations of the subject, by no microscope can structural parts be distinguished if they are so near to each other that the first bundle of light rays produced by diffraction can no longer enter the object simultaneously with the undiffracted cone of light.

Scientific American Supplement.

No. 12.

FOR THE WEEK ENDING MARCH 18, 1876.

PUBLISHED WEEKLY,
AT THE
OFFICE OF THE SCIENTIFIC AMERICAN,
No. 37 Park Row, New-York.

MUNN & CO., Editors and Proprietors.

O. D. MUNN. A. E. BEACH.

The Scientific American Supplement is uniform in size with the *Scientific American*. Terms of subscription for Supplement, $5.00 a year, postage paid, to subscribers. Single copies, 10 cents. Sold by all newsdealers throughout the country.

COMBINED RATES.

The *Scientific American* and Scientific American Supplement will be sent together for one year, postage free, to subscribers, on receipt of $7.00.

Remit by postal order. Address,
MUNN & CO., Publishers,
37 Park Row, New-York.

THE INTERNATIONAL EXHIBITION OF 1876.

THE SHOE AND LEATHER BUILDING.

No. III.

Few of your readers, not in some way connected with it, probably have any idea of the magnitude of the leather industry in this country; the history of the above-mentioned building, now in course of construction as a part of the Centennial Exhibition, will illustrate the extent and value of it, perhaps, better than any collation of mere figures could do. Very soon after the initiation of the Centennial Exhibition, it became apparent to those interested in the different manufactures consisting in whole or in part of leather, that, in order to have this great interest adequately represented among the other principal industries of the country, it would be necessary to have a far larger amount of space upon which to display their products than would be possible to obtain within the buildings originally provided by the Centennial Commission. The advantage also of having the great variety of machinery incidental to, and the various processes of, the manufacture of all articles of leather grouped together with what may be more nearly considered as the raw material of the trade, was very evident. Under the general arrangement and classification of goods for the main exhibition buildings, the several branches of the business would necessarily be displayed not only in separate buildings, but also in different parts of the same building; it became a self-evident proposition, therefore, that a building devoted exclusively to the display of leather products and manufactures, if such could be had, would result in an exposition of that branch of industry of a character very much to be desired, and of a magnitude never before approached in any country. Accordingly, a number of the most prominent men of the trade, among whom may be mentioned Messrs. Jackson S. Schultz and J. B. Hoyt, of New-York; Messrs. A. L. Coolidge and C. W. Hersey, of Boston, and Mr. Alexander B. Brown and others, of Philadelphia, put their heads together with that purpose in view. That they have succeeded will be witnessed by the elegant and costly structure now nearly completed, a representation of which is given on page 180.

The leather trade of this country is said to be second in importance and value only to that of agriculture. The hides of the ox, horse, buffalo, deer, goat, sheep, dog, bear, mink, sable, seal, alligator, and even the much-despised rat, are manufactured into an almost endless variety of leather and leather goods. There is an enormous amount of capital invested in the business of tanning alone, of which establishments there are in the United States over 3500; if we add to this more than 10,000 manufacturers, such as curriers, morocco and sheep-skin dressers, and those who produce the thousand and one articles of which leather forms the whole or a component part, and consider that the total annual product of these now exceeds in value $200,000,000, we have some idea of the extent of this business.

The money required for the erection of the Shoe and Leather Building was raised by subscription from members of the trade, including some of the most prominent banks more or less directly connected with or interested in the business, a number of which are known in the East particularly as hide, shoe and leather institutions. Having obtained from the Centennial Commission a suitable location, described in my letter of January 31st, a representation committee of the leather manufacturers took the matter in hand, and entered into a contract with Messrs. J. H. Coffrode & Co., of this city, for the erection of the building from plans of the architect, Mr. Alexander B. Barry. The cost of the structure, including its embellishments, as originally designed, will be not less than $35,000, and if it be enlarged, as is just now in contemplation, it will reach nearly if not quite $45,000.

As a large proportion of this display will consist of machinery and the processes of manufacture, the whole has been placed under the direction of the Chief of Bureau of Machinery. The products to be exhibited in this building will come under the following general heads: shoe and leather machinery, belting, boots and shoes, sole leather, rough "skirting," harness, kip and calf leathers, morocco and sheep, harness and saddlery, saddlery hardware, rubber goods, trunks, valises, and travelling-bags, pocketbooks, etc., and blacking, polish, etc.

Besides the space devoted to exhibitors, the building will be provided with reading and writing rooms, telegraph and post offices, meeting and cloak rooms, etc. On either side of the main entrance to the building is a stairway leading to the second floor, and to a gallery running across the end 8 feet wide and 112 feet long, from which an unobstructed view of the whole interior may be had, and a hall leads from this to a balcony facing Belmont avenue, giving a commanding view of the surrounding buildings.

As an instance of the extent to which the leather men of the country are engaging in this enterprise, it may be stated that there are already nearly 600 applications for space from them, and such is the demand of each proposed exhibitor for floor area, that long ago it was found that the building was but little over half large enough to satisfy them. Such representative cities in the trade as Boston, Haverhill, and Lynn, Mass., Newark, Philadelphia, New-York, Wilmington, Del., and Cincinnati, send from 40 to 60 applications each, and so great has become the pressure for space that within the past few days it has been in contemplation by the Centennial Commission to add from 80 to 100 ft. to the length of the building. The original project of erecting a trophy, in symbolic illustration of the trade, in the centre of the building, has, owing entirely to the great want of space, been abandoned. In point of fact, it is plain that the original estimate of the Commissioners as to the amount of space which could probably be filled in the various departments was far behind what has been found to be the actual demand, in consequence of which we see annexes and additions to nearly every one of the original structures, now in process of erection, and it is quite probable that the shoe and leather building will be no exception to the rule.

A liberal allotment of space within the building has been made for the accommodation of foreign exhibitors in this line, which, being greater than was at first contemplated, renders this addition to it the more necessary.

On that part of the floor to be devoted to machinery and an exhibition of the various and interesting processes of manufacture, there will be displayed all the latest improved and most refined methods of producing boots and shoes, harness, saddles, whips, etc., together with the machines employed in them. There is probably no one branch of industry in which labor-saving machinery has been carried to greater perfection than in the boot and shoe trade, and this part alone will constitute one of the principal features of the exhibition. Here will be seen machinery for the performance of almost every conceivable operation in the trade, from mills for grinding the bark with which the skins are tanned, with currying, hairing, graining, splitting, pebbling, polishing, buffing, and coloring leather, up to the intricate and ingenious machines employed in the cutting, sewing, pegging, forming, and finishing all varieties of boots and shoes; and their name is legion. There will be machines which make the pegs and secure the soles upon the boots and shoes, by means of them, in one operation; and others which make a kind of screw of brass wire, and insert them in the shoe or boot for the same purpose. To enumerate them here, however, would be out of the question, much less to describe them. I will leave such, therefore, for some future task. A 40 horse-power steam-engine, and a boiler of about 60 horse-power capacity, exhibited by Messrs. Bowser & Co., of Fort Wayne, Ind., will furnish the motive power, as well as the steam used in some of the processes incidental to the preparation of leather. Apart from the driving of the machinery, and in connection with this boiler, there will be a novel furnace, by Mr. J. B. Hoyt, of your city, something akin in principle to his well-known tan-burning furnace. It is claimed by Mr. Hoyt that in this furnace he succeeds in consuming bituminous coal to that degree of perfection that at no part of the process, even when newly charging the fires, will there be the least escape of uncombined carbon in the solid state, as in the dense smoke usually attending the use of this kind of coal, and if he is as successful as he claims to be, this furnace will be of great interest to our foreign visitors, particularly from Great Britain, where the bituminous variety of coal forms so considerable a part of their fuel; and little less so to the denizens of such smoky cities as Pittsburg from among ourselves. In the operation of this furnace the combustion takes place in a chamber which is not even very near, much less directly exposed to any part of the boiler. A very high temperature obtains in the furnace proper, under which the volatile or gaseous parts of the coal are rapidly distilled, separating them from the fixed carbon or coke; and only the highly-heated products of the distillation and subsequent combustion of the coal come in contact with the heating surfaces of the boiler. The high temperature in the furnace admits of the introduction of a sufficient amount of atmospheric air to completely combine with the gases which bituminous coal contains in such considerable quantity, something as with the common argand-burner, and the combustion of these gases, instead of being allowed to escape into the air partially unburnt, as is the case whenever smoke is produced, serves, through the greater heat developed, to maintain the high temperature necessary, when once in operation. The method consists in introducing the fuel in limited quantities at short intervals of time to different parts of the furnace, through openings made for the purpose, so as to produce as nearly as possible a uniform volume of the distilled gases, at the same time admitting the necessary quantity of atmospheric air over the surface of the bed of fuel upon the grates to effect their complete chemical combination, and as these operations are all carried on with approximate regularity, the temperature of the furnace varies but little, and nothing but comparatively true carbonic acid gas and vapor of water, together with the free nitrogen of the air, escape from the chimney, or indeed enter the boiler-flues.

Altogether the display to be made in this building will be to the leather interest of the world the most important event in its history, and must prove of very great and lasting benefit to it in this country; while to even the casual visitor, who may enter the building with only the curiosity of the sightseer, it will doubtless bring the impression that "there is nothing like leather."

Without appearing to harp upon this theme too persistently, it continues to be painfully apparent that exhibitors are worse than laggard in their preparations, and in getting their articles in place. This may not be as true of the other as it most certainly is of the machinery department, where it is well known that so much greater time is required in placing the exhibits than is necessary elsewhere. With the single exception of the Messrs. William Sellers & Co., of this city, who have now a large number of their machines on the floor, nothing of any weighty character has made its appearance during the past week; and this fact can not be too forcibly impressed upon exhibitors: that unless they are nearer ready on the opening day than now seems probable, they will not only find themselves under much embarrassment in placing their goods when their own time arrives, but they will lose much valuable time immediately succeeding the opening day, during which local visitors may be expected to give a more leisurely examination of their wares than may be looked for after the Exhibition has been open a longer time. In view of these facts, it is the most earnest desire of the management that exhibitors defer nothing which can as well be done at once. If all the exhibitors who are in reality ready now to place their goods, would do so without waiting simply because they have an abundance of time, a very great advance will be made toward insuring a perfected display upon the opening day.

J. T. H.

Philadelphia, Feb. 28, 1876.

It has been found necessary to enlarge the Art Gallery by a wing on the north and south sides, increasing its size about one sixth. This extension is rendered absolutely necessary on account of foreign requirements in the exhibition of statuary and paintings. One of the wings will contain groups of statuary to be sent from Italy, which will not only be in the best style of art, but form a very attractive feature of the Exhibition.

CENTENNIAL JURY WORK.

Perhaps the most important and valuable of New-York's contributions to the great Exhibition is the plan of jury work suggested by Mr. Beckwith. As United States Commissioner-General at the Paris Exposition, and a critical student of the failings of the Vienna Fair, he was led to the conclusion that as regards the diffusion of reliable and useful information, international exhibitions have fallen short of the promise implied in the great labor and expense they involved; and that the widespread dissatisfaction which has uniformly followed the close of jury work is strong evidence that the system of awards hitherto adopted has not been well suited to the purposes of such exhibitions. When called upon to suggest a plan for the Centennial Exhibition, he therefore proposed a plan in many respects radically new, yet so fair and feasible that we have failed to hear of a single objection to it, while it has met the approval of exhibitors and commissioners everywhere. The London *Times* pronounces it the first fair and thorough system yet devised.

The failure of preceding juries has arisen chiefly from their unwieldy size, and from the circumstance that the reasons for their decisions, individually, have not been given, nor any person outside the juries informed on what grounds awards were made. "The medals when distributed were as silent as the verdicts; moral responsibility for the decisions attached to no one, and the awards thus made conveyed as little useful information and carried as little weight as anonymous work usually carries."

All this will be changed at Philadelphia. The usual international jury of from six hundred to a thousand members will be dispensed with, and for it will be substituted a body of 200 judges, one half foreign, chosen individually for their high qualifications. For the confusing system of graduated medals, whose relative value the public never understands, there will be substituted uniform tokens of approval, to be followed by carefully written reports on the inherent and comparative merits of each product thought worthy of an award, with the reasons for the awards vouched for by the signatures of their authors. The professional judgment and moral responsibility of the judges being thus involved, the integrity of their report will be insured. The Commissioners, being free to select judges from the best sources, will be able, it is thought, to secure a jury much better fitted for their delicate and responsible work than any that could be secured by the old method of representation.

The jury will be divided into sections corresponding with the seven departments of the Exhibition, and the sections subdivided into committees of three or four. To each committee will be assigned the duty of examining and reporting upon one or more classes and recommending articles for awards.

The following is an outline of the plan:

First. Awards shall be based upon written reports attested by the signatures of their authors.

Second. Two hundred judges shall be appointed to make such reports, one half of whom shall be foreigners and one half citizens of the United States. They will be selected for their known qualifications and character, and will be experts in departments to which they will be respectively assigned. The foreign members of this body will be appointed by the commission of each country, and in conformity with the distribution and allotment to each, which will be hereafter announced. The judges from the United States will be appointed by the Centennial Commission.

Third. The sum of $1000 will be paid to each commissioned judge for personal expenses.

Fourth. Reports and awards shall be based upon inherent and comparative merit. The elements of merit shall be held to include consideration relating to originality, invention, discovery, utility, quality, skill, workmanship, fitness for the purposes intended, adaptation to public wants, economy and cost.

Fifth. Each report will be delivered to the Centennial Commission as soon as completed fo final award and publication.

Sixth. Awards will be finally decreed by the United States Centennial Commission, in compliance with the act of Congress, and will consist of a diploma with a uniform bronze medal and a special report of the judges on the subject of the award.

Seventh. Each exhibitor will have the right to reproduce and publish the report awarded to him, but the United States Centennial Commission reserves the right to publish and dispose of all reports in the manner it thinks best for public information, and also to embody and distribute the reports as records of the Exhibition.

JAPANESE WORK AT THE CENTENNIAL GROUNDS.

The most curious part of the day's work was the driving of a number of piles, each six feet long and ten inches in diameter, upon which is to rest, like a corn-crib, a rectangular structure eighty-four by forty-four feet, and in general appearance like the pictures of Japanese houses that children see in their primers. The way in which the Japs managed the pile-driving brought many a burst of laughter from the bystanders. They had a portable tripod about twenty feet high, with two fixed pulleys under the apex, from which was suspended by a grass rope a cylindrical iron hammer weighing three hundred pounds. Six Japs on each side of the machine seize a grass rope which passes over one of the pulleys; the foreman stands at one side, holds up his forefinger, closes one eye, and then, apparently not satisfied with this, picks up a short stick, holds it in a vertical position between his two forefingers, sights the pile with it, and at last winks with both eyes as a signal to the workmen that the ceremony of Japanese plumb-bobbing is concluded; whereupon the hammer moves up and down very rapidly, driving the pile an inch into the earth at every descent, until it is time for the foreman to do a little more plumb-bobbing. One pile struck a rock; and, while every body was wondering how things were to be managed, one of the gang ran off and brought back something that had teeth like a saw, but which was shaped like a butcher's cleaver; but the panting Jap had severed the stick in about half the time required for a saw of American make to do the same work.

The Japs draw their planes towards them, instead of pushing them from them, and use an ink-line instead of a chalk-line. It resembles a tape-line case, and contains a sponge which may be saturated with ink of any color; through this sponge the cord may be drawn and then wound up, dispensing with the tedious process of chalking. The holes for the piles were marked out in this odd way: two posts, one at each end of the foundation, were connected at the top by a tightly-drawn cord; from end to end of this, the mandarin foreman walked with his rule, measuring off spaces, which he marked by tying bits of string in bow-knots to the main cord, and

then standing off to go through his delicate operation of plumb-bobbing, which he repeated every time his men removed the tripod to drive a new pile. Their adze is a remarkable tool, chiefly on account of its handle, which is shaped as Hogarth's line of beauty might be if warped by torrid weather. The wielder of this tool stands over his timber, and hacks away, driving the steel far underneath his foot at every blow. When the ropes of the pile-drivers were too long, the foreman fastened blocks of wood in slip-knots to shorten them; but one of these slipped and dropped on the head of a young Jap, causing him to let go the rope, fall backward, and roll over to a big log, upon which he sat down to rest himself and laugh.

The Japanese square is eighteen and a half inches long and nine and a quarter wide, and is graduated, like the rule, by the decimal system, nine and a quarter of their inches being equal to eight of ours.

In the bamboo building not a nail will be used; all the material is there, dovetailed, bevelled, and mortised, ready to be fastened together with wooden pins. These artisans live in a frame structure within the inclosure, do their own cooking and laundry-work, and live on soup, rice, and dried meats, which they brought with them in hermetically-sealed cans. The officials having charge of Japanese operations in the park refuse to give the slightest information as to what they are doing. When asked about their building and intended exhibition, the questioner is invariably put off with, "Wait till comes time; you then see." It displeases them when spectators laugh at the uncouth mechanical operations of the flat-nosed and tawny-featured Orientals.—*Philadelphia Times.*

EXHIBITION NOTES.

THE Centennial billiard tournament will be a most interesting trial of skill. All the leading players of Europe and America will compete. The prizes thus far offered amount to $5000.

BELL'S *Life* says that Robert Watson Boyd has completed negotiations for a four-oared crew to go to America during the ensuing regatta season. The crew will be composed as follows: Robert Bagnall (bow), W. Nicholson, Robert Chambers, and Boyd himself as stroke. Boyd has challenged any crew in England to row over the championship course on the Thames or Tyne. If this challenge is not accepted, he will assume the title of champion. The four will then proceed to America as the representative English crew.

M. MAURICE DELFASSE, in charge of the Belgian Legation in Washington, has notified this Government that the Royal Belgium Commission for the Centennial Exhibition will consist of Count A. D. Oultremont as Permanent Commissioner, to have the chief supervision of the various departments; M. J. Beco, mining engineer, as Deputy Commissioner, to have charge of the disposition of the machinery, manufactured articles, etc.; M. J. Vanbree, of the Ministry of the Interior, as head of the department of Fine Arts, and M. J. Gody, of the Ministry of Public Works, as head of the Commercial Bureau.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION. LONDON, JANUARY 28.

LECTURE BY PROF. HUXLEY.

THE theatre of the Royal Institution was crowded to its utmost capacity to hear Professor Huxley discuss the "Border Territory between the Animal and Vegetable Kingdoms." Professor Huxley has the happy art of expounding with perfect clarity of both language and thought; and while an audience of intelligent persons can always listen to the pellucid flow of words with perfect ease and apprehension, there are always things to be thought about for those who look a little deeper than the brilliant surface.

While the experiments were in progress which formed the subject of Professor Tyndall's lecture on the Friday before, Professor Huxley was called in to express an opinion upon the nature of a minute motile organism, about $\frac{1}{1000}$ of an inch in diameter, and therefore about as large as a human red blood-corpuscle. Whether this was to be called a plant or a vegetable, Professor Huxley was uncertain when he first made its acquaintance, and he remained uncertain still. The object of the lecture then was to justify the grounds of his dubiety.

Cuvier pointed out a number of distinctions between animals and plants, which were perfectly valid as far as they went. They are not, however, applicable now in the light of our vastly greater knowledge, especially of microscopic organisms. The lecturer stated the case for the animal and vegetable kingdoms as it now stands with great clearness. We quote the summing up from an abstract which appeared in the *Daily News*, and which has a neatness in its condensation which suggests something more than the notes of one who merely heard the lecture.

"The definition of an animal based on its possession of an alimentary cavity or internal pocket has broken down. With the advance of microscopic anatomy the universality of the fact itself has ceased to be predicable. Many animals of even complex structure, which live parasitically within others, are wholly devoid of an alimentary cavity. Their food is provided for them, not only ready cooked, but ready digested, and the alimentary canal, become superfluous, has disappeared. Again, the males of most Rotifers have no digestive apparatus, and are to be reckoned among the few realizations of the Byronic ideal of a lover. Finally, amidst the lowest forms of animal life the speck of gelatinous protoplasm which constitutes the whole body has no permanent digestive cavity or mouth, but takes in its food anywhere, and digests, so to speak, all over its body. Yet, although Cuvier's leading diagnosis of the animal from the plant will not stand a strict test, it remains one of the most constant of the distinctive characters of beings, inasmuch as, if for the possession of an alimentary cavity be substituted the power of taking solid nutriment into the body and there digesting it, the definition so changed will cover all animals, except certain parasites and the few and exceptional cases of non-parasitic animals which do not feed at all. On the other hand, the definition thus amended will exclude all ordinary vegetable organisms. For the erroneous conception of the chemical differences and resemblances between the constituents of animal and vegetable organisms, Cuvier is not responsible, as his views coincided with those of contemporary chemists. It is now known that nitrogen is as essential a constituent of vegetable as of animal living matter, and that the latter is, chemically speaking, just as complicated as the former. Starchy substances, cellulose and sugar, once supposed to be exclusively confined to plants, are now known to be regular and normal products of animals. Amylaceous and saccharine substances are largely manufactured, even by the highest animals; cellulose is widespread as a constituent of the skeletons of the lower animals; and it is probable that amyloid substances are universally present in the animal organism, though not in the precise form of starch. Moreover, although it remains true that there is an inverse relation between the green plant in the sunshine and the animal, in so far as under these circumstances the green plant decomposes carbonic acid and exhales oxygen, while the animal absorbs oxygen and exhales carbonic acid, yet the exact investigations of modern chemists have demonstrated the fallacy of drawing any general distinction between animals and vegetables on this ground. In fact, the difference vanishes with the sunshine, even in the case of the green plant, which in the dark absorbs oxygen and gives out carbonic acid, like any animal; while those plants, such as the fungi, which contain no chlorophyll, and are not green, are always, so far as respiration is concerned, in the exact position of animals. They absorb oxygen and give out carbonic acid."

With respect to the nervous system as a distinctive character of animals, Professor Huxley could only remark that the behavior of the Venus's Fly-Trap could be distinguished in no way from those acts of contraction known as "reflex." And as our notion of a nerve was becoming vastly generalized, so that it meant now nothing more than a filament of protoplasm capable of transmitting an impulse, there was no reason why such structures should not be found in plants. Professor Huxley would, however, no doubt admit that there is very little evidence in favor of a continuity of protoplasm from cell to cell in their ordinary tissues. In the peculiar structures known as sieve-cells, the protoplasm of two adjoining cells communicates through peforations in the intevening partition or "sieve." But this arrangement appears only to subserve the distribution of nutrient matter, and is not found in the parts of plants which exhibit mobility.

The upshot of the matter was that the animal and vegetable kingdoms converged to a common starting-point, in which their characteristic differences were merged. It was a grievous error to suppose that this statement gave any support to the notion maintained by Dr. Gros and others, that members of either series could put on forms belonging to the other. Once their path was chosen, they stuck to it with perfect definiteness.

"Keen and patient research induces the belief that such an insensible series of gradations leads to the monad that it is impossible to say at any stage of the progress—Here the line between the animal and the plant must be drawn. It is therefore a fair and probable speculation, though only a speculation, that as there are some plants which can manufacture protein out of such apparently intractable matters as carbonic acid, water, nitrate of ammonia, and metallic salts, while others need to be supplied with their carbon and nitrogen in the somewhat less raw form of tartrate of ammonia and allied compounds, so there may be yet others, as is possibly the case with the true parasitic plants, which can only manage to put together materials still better prepared, still more nearly approximating to protein, until such organisms are arrived at which are as much animal as vegetable in structure, but are animal in their dependence on other organisms for their food. The singular circumstance observed by Meyer that the torula of yeast, though an indubitable plant, still flourishes most vigorously when supplied with the complex nitrogenous substance, pepsin; the probability that the potato disease is nourished directly by the protoplasm of the potato-plant; and the wonderful facts which have recently been brought to light respecting insectivorous plants, all favor this view, and tend to the conclusion that the difference between animal and plant is one of degree rather than of kind, and that the problem whether in a given case an organism is an animal or a plant may be essentially insoluble."

BRITISH SCANDINAVIAN SOCIETY. JANUARY.

HIS EXCELLENCY BARON HOCHSHILD in the chair.—Mr. R. T. Pritchett, F.S.A., read a very interesting paper on some recent discoveries of tumuli belonging to the Viking Age. One of these was found at Nydam in Slesvig, and may be considered as dating from the latter part of the fourth century. It contained a boat eighty feet in length and fourteen feet broad, in shape singularly like that now used on some parts of the Norwegian coast, with a very high prow. The arms found in it, the amber, the Cufic coins, all pointed to its having been covered up towards the close of the First Iron Age. Mr. Pritchett further described a tumulus of unusual size lately opened near the Nordfjord in Norway, and dating apparently from the year 800. It was stored with all the magnificent belongings of a Viking chieftain. A bowl of precious enamel, a store of amber, a massive belt of bronze, rank among the most splendid trophies of the Viking period which have come down to us. The lecturer described some stone balls, flattened at one side, with a dint in the centre of the base. He regarded these as marbles, flattened for use on board ship; but in the discussion that ensued, Professor Bryce argued that they belonged rather to a peculiar game now no longer in vogue, and played on shore. Professor Magnusson supported this view with citations from the sagas.

[Medical Record.]

NEW-YORK MEDICAL JOURNAL ASSOCIATION.—FEBRUARY 4, 1876.

DR. E. G. LORING, PRESIDENT, IN THE CHAIR.

RECENT DISCOVERIES IN THE PHYSIOLOGY AND PATHOLOGY OF THE BRAIN.

DR. EUGENE DUPUY, in a plain and interesting manner, directed the attention of the Association to certain points relating to the function of different parts of the brain. His remarks were intended chiefly to overthrow the doctrine of localized functional centres, and were confined for the most part to the pathological lesions attending hemiplegia, hemi-anæsthesia, aphasia, and epilepsy. A review was made of cases from Charcot, Hitzig, Westfall's clinic, etc., and in these reports Dr. Dupuy believed he found just as much to disprove as to sustain the idea that there are in the brain localized centres for nerve force. Dr. Dupuy referred to the physiological experiments which have been performed upon animals with the view of locating such centres of nerve force; but he did not believe that they had substantiated the theory of localization. The doctor denies the excitability of the cortical substance of the brain. Aphasia may be developed by lesions independent of the island of Reil, or its immediate surroundings.

The natural fluid found in the cerebral substance and cavities constitutes one of the very best media for conducting electricity, hence must be removed as much as possible; absorbing with blotting-paper is a good method, otherwise it will enter as a disturbing factor to the obtaining of exact results. When the experiments of Hitzig, Ferrier, and others have been repeated by Dr. Dupuy, after having taken such precaution as would enable him to apply the electrodes to a dry cortical substance, he has failed to verify the statements made by these experimenters. Dr. Dupuy's remarks were listened to with marked attention.

Dr. Dalton followed with remarks, in the course of which he referred to the fact that definite muscular contractions are produced in a living animal by the application of a very faint discharge of electricity to the cortical substance of the brain. Whether this is due to a physiological irritation conveyed downward, or is due to a simple diffusion of electricity to the deeper parts, is a question. The simplest explanation is, that the effect is produced by the conveying of a physiological irritation downwards. If it is due to a simple diffusion of electricity, why do we fail to get a certain set of contractions when the electrodes are applied elsewhere than over certain points? This fact was alluded to merely from its suggestive import, rather than because it carried with it any positive proof.

There are certain pathological lesions which are followed by certain clinical phenomena that are well established. For instance, when a patient has paralysis of motion upon one side, it may be associated with lesions upon the same side or opposite side of the brain, but in by far the greater majority of cases upon the opposite. Now, when hemiplegia occurs from lesions upon the opposite side of the brain, it is due to a well-known anatomical reason; and when it occurs from a lesion upon the same side of the brain, there is doubtless an anatomical reason, the same as in the other instance, except that it has not yet been found. The subject is full of interest, and requires carefully conducted experiments to settle certain perplexing questions arising both in physiology and pathology.

Dr. Dupuy remarked with regard to the impression being conducted downward into or through the corpus striatum, that he had divided all the fibres going to that body, breaking it up entirely, and obtained the same muscular contractions as when the corpus striatum remained intact.

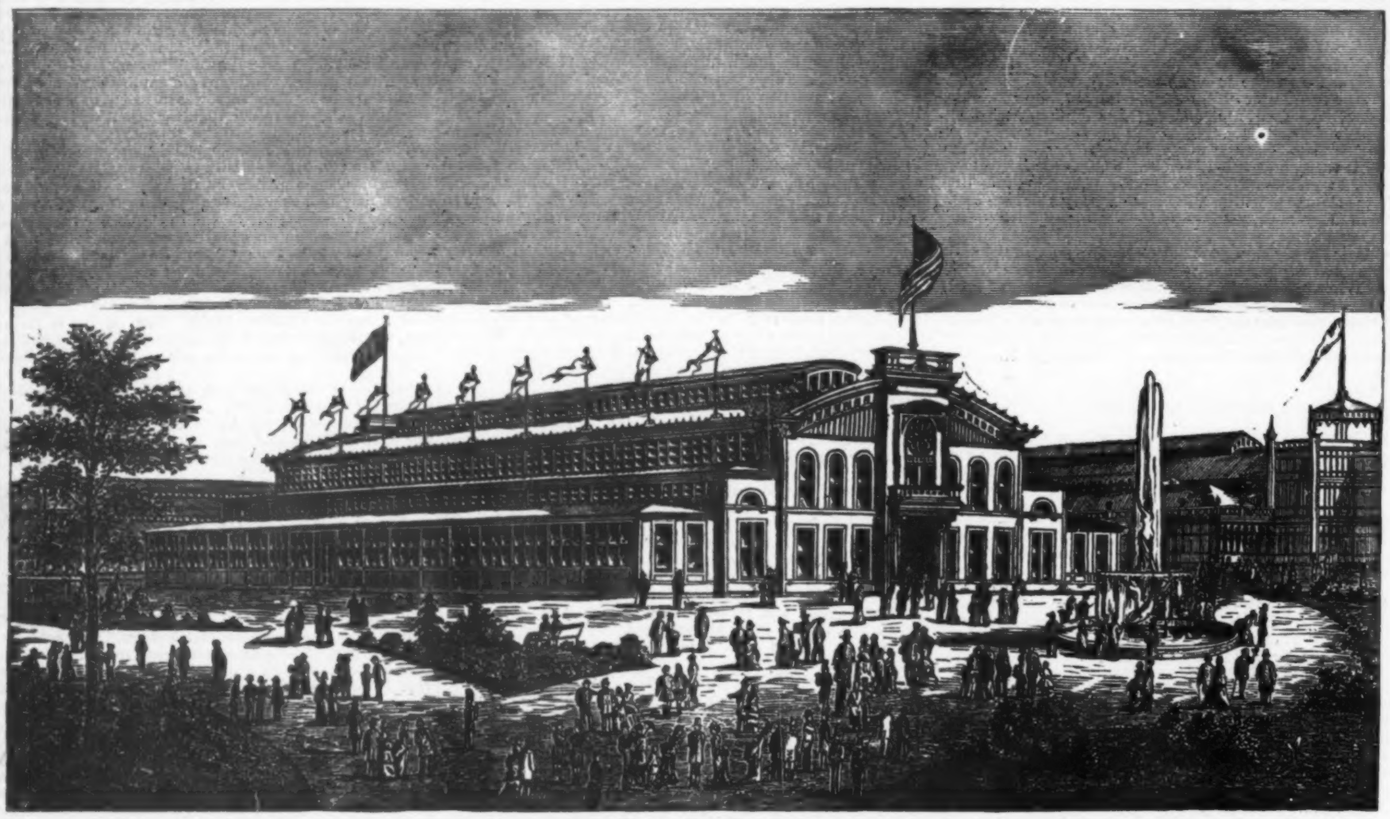
GEOLOGY.

THE ORIGIN OF THE PRIMARY ROCKS.

AT the last meeting of the Geological Society of London, a paper on "The Physical Conditions under which the Upper Silurian and succeeding Palæozoic Rocks were probably deposited over the Northern Hemisphere," was read by Henry Hicks, F.G.S. The author, after pointing out the lines of depression explained in his former paper to the Society, now further elaborated the views then propounded by him, by carrying his examination into the higher Palæozoic series and into more extensive areas. Beginning at the top of the Lower Silurian, where he first recognizes the evidence of a break in the Palæozoic rocks, he proceeded to show that this break was restricted to very limited areas, and almost entirely confined to the parts which had been first submerged, and where the greatest thickness of sediment had accumulated on both sides of the Atlantic, and hence where the pre-Cambrian crust had become thinnest. On the European side this break occurred where volcanic action had taken place, and has doubtless to be attributed to the combined action of upheaval of portions of the crust and the heaping up of volcanic material, the latter in some cases forming volcanic islets of considerable extent. He strongly objected to look upon these breaks, even in the British area, where they are most marked, as evidence of a want of continuity over other and far greater areas, or to admit that even where there was conformity in the rocks at this point, "great intervals of time are indicated, unrepresented by stratified formations." The conformity found in extensive and widely-separated areas is proof also that a gradual contraction took place of an enormous portion of the crust in the northern hemisphere in Palæozoic times; and the breaks at the close of the Lower Silurian and in the Devonian are not indications of an arrest in the general subsidence. After indicating the changes which must have taken place in the climate from the gradual spreading of the water and the evidence to be derived from the consideration of the deposits and the faunas, the author drew the following general conclusions: 1. That the condition of the northern himisphere, at the beginning of Palæozoic time, was that of immense continents in the higher latitudes, traversed by mountainous ranges of great height, but with a general inclination of the surface, on the one side (European) to the southwest and south, and on the other side (American) to the southeast and south. 2. That these continents were probably covered, at least in their higher parts, with ice and snow; and that much loose material had consequently accumulated over the plains and deeper parts, ready to be denuded off as each part became submerged. This would account for the enormous thickness of conglomerates, with boulders, grits, and sandstones, found in the early Cambrian rocks, and also to a certain extent for their barrenness in organic remains. 3. That the depression over the European and American areas was general from at least the latitude of 30° northwards; that the parts bordering the Atlantic were the first to become submerged; the lower latitudes also before the higher. 4. That the depression could not have been less altogether, for the whole of the Palæozoic, than 50,000 feet; and that conformable sediments to that extent are found over those parts of the areas first submerged, and which remained undisturbed. That volcanic action was chiefly confined to parts of the regions which became first submerged; that the immediate cause of these outbursts was the weakness of the pre-Cambrian crust at those parts, from the great depression that had taken place, it being too thin there to resist the pressure from within, and to bear the weight of the superincumbent mass of soft sediment. 5. That the seat of volcanic action at this time was at a depth of probably not less than 25 miles, as sediments which were depressed to a depth of from 9 to 10 miles do not indicate that they had been subjected to the effect of any great amount of heat, and are free from metamorphosis. 6. That the climate at the early part of Palæozoic time was one of very considerable, if not extreme, cold, and that it became gradually milder after each period of depression. That towards the close of the Palæozoic, in consequence of the elevation of very large areas, and to a great height, the climate became again more rigorous in character. 7. That the various changes which took place over the northern latitudes during Laurentian and Palæozoic times allowed marine and land life to develop any progress in those areas at interrupted periods only; consequently most of the progressive changes in the life had to take place in more equatorial areas, where the sea-bottom was less disturbed, and where the temperature was more equable. Any imperfection therefore in the Palæontological record belonging to these early times should be attributed to these and like circumstances; for whenever an approach to a complete record of any part of the chain is preserved to us, the evidence points unmistakably to an order of development, through a process of evolution from lower to higher grades of life.

THE SHOE AND LEATHER BUILDING.

The interior of the building presents an open space 256 feet long and 160 feet wide. The roof is supported by columns 16 feet apart, the central section being a curve 80 feet wide, of the Howe truss pattern, over which is a Louvre ventilator 26 feet wide, running the length of the building



THE INTERNATIONAL EXHIBITION OF 1876.—THE SHOE AND LEATHER BUILDING.

60 feet above the ground. The pavilions are 20 and 30 feet high. The ground floor of the building is divided as follows:

An aisle 15 feet wide and 300 feet long runs through the centre, and on either side is one 10 feet wide, parallel with the centre aisles. Across the centre of the building is a passage-way 10 feet wide, at one end of which is a doorway leading to Machinery Hall on the north. The east and west sections of the ground floor have aisles 14 feet wide. There are eight main exhibition spaces for exhibits (bounded by the aisles) 20 feet in width and 117 feet in length, and four exhibition spaces of 20 feet in width by 114 feet in length.

On the right and left of the main entrance to the building are stairways leading to the second floor, in front of which, through the width of the building, is placed a gallery, 8 feet wide and 112 feet long. From this gallery an unobstructed view of the whole building is obtained. A hall 16 feet wide divides the second story into two parts, and leads to a balcony facing Belmont avenue, giving a commanding view of Machinery Hall, Memorial Hall, Main Building, and the concourse approaching the Exhibition grounds. On either side of the hall is a ladies' and gentlemen's parlor respectively, 16 by 32 feet. The first floor is divided into waiting-rooms, reading-rooms, register-office, wash-rooms, etc.

The second story in the rear of the building is partitioned for offices. Provision is made to introduce shafting, drainage, water-supply, gas, etc. The columns supporting the roof are constructed in such a manner as to be connected by iron rods.

The spaces will be mostly arranged with artistic cases for the display of gentlemen's, ladies', misses' and children's shoes and all kinds of leather fabrics.

Packages and shoe machinery can be delivered at the doors of the building by railroad. The central station of the city passenger-railway is within 100 yards of the main entrance of the building, and altogether the location is a most desirable one.

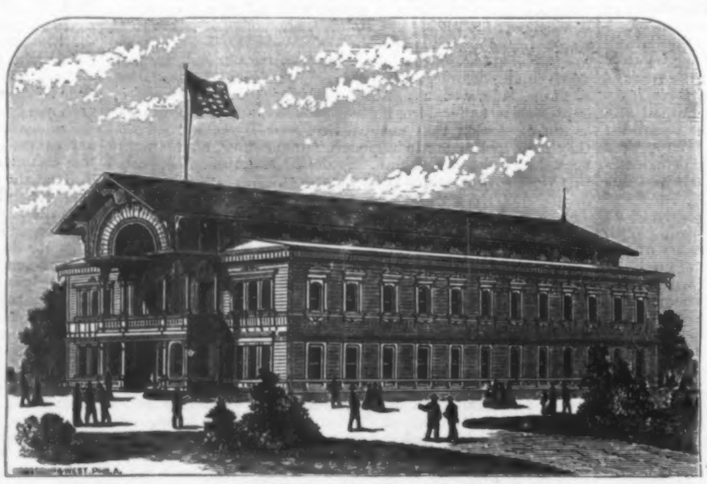
Ground plans of the Shoe and Leather Building can be examined by those who have made application for space to exhibit shoe and leather fabrics at the offices of Schultz, Southwick & Co., 65 Cliff street, New-York, and Alex. P. Brown, 910 Arch street, Philadelphia. The floor spaces, side elevation and cross-sections of the building can be apportioned to exhibitors without any extra overcrowding, so that all will be satisfactorily accommodated. The arrangement proposed is to set apart all the wall space, which will be amply sufficient for each tanner to make his display of sole leather. The tannages of oak leather, comprising those of the Louisville Association, Pittsburgh, Philadelphia, Baltimore and Flintstone tanneries, are to be exhibited on the north elevation, while all hemlock and union crop leathers are to be arranged on the south side of the building. The spaces directly opposite these will display upper leather, calf-skins, kips, splits, etc. Toward the centre of the building will be arranged the finer leather fabrics—Curaçoa kid, morocco, sheep and lamb skins, skivers, fine harness and saddlery. On the right of the main entrance, the floor space, 20 by 117 feet, will be devoted to case displays of gents', ladies', misses' and children's fine shoes. Over 500 applications, thus far, have been received and entered, exclusive of the foreign representations. Exhibitors' permits for space and allotment will be granted by Capt. John S. Albert, Chief of the Bureau of Machinery of the International Exhibition, who will also personally superintend the placing of the shoe machinery, erection of hangers for shafting, engines, etc.

The *Shoe and Leather Reporter* says that the following space has been already applied for as estimated by the committee:

	Square Feet.
Boots and shoes	3,887
Sole leather	3,900
Rough leather	75
Harness, kip and calf	1,200
Morocco and sheep	1,158
Harness and saddlery	1,508
Rubber goods	630
Trunks, etc.	814
Blacking	142
Saddlery hardware	558
Machinery	1,726
Foreign (estimated)	5,000
Total	20,598

THE CENTENNIAL NEWSPAPER EXHIBITION.

Our engraving shows the building now in course of erection at the Centennial grounds in Philadelphia, to be used



THE INTERNATIONAL EXHIBITION OF 1876.—THE NEWSPAPER BUILDING.

solely for an exhibition of newspapers. It occupies a conspicuous position near the miniature lake, on a line between the United States Government Building and Machinery Hall.

The plan of exhibition is an alphabetical arrangement of partial files of each newspaper or periodical in such a manner as will make them instantly accessible: the space devoted to each bearing a label with the name of the publication printed thereon, and further designated by a number, by means of which a stranger, upon reference to his catalogue, will be able at once to approach the section of the building where the particular journal which he desires to examine or refer to may be found.

The cases containing these files will form alcoves similar to those in public libraries for the arrangement of books; these alcoves forming long tiers, one on each side of the building throughout its entire length. a portion of the space between being reserved for the accommodation of attendants, leaving a passage-way for the public eighteen feet in width extending from one end of the structure to the other.

The second story, approached by four flights of stairs, is devoted to reading-rooms for the accommodation more especially of newspaper men, and will be supplied with conveniences for correspondents.

A catalogue giving the name of each newspaper, its frequency of issue, and the number which designates the position allotted to it, together with such statistical information as will serve to convey a comprehensive knowledge of the nature and extent of the business of newspaper publishing in America, will be issued in a compact form, not differing very much in size and appearance from the Official Catalogues of the four departments of the principal exhibition.

Mr. George P. Rowell, of New-York, will assume the management of the enterprise, and with him will rest the responsibiltty of making it what it should be.

For the suggestion of this exhibition of journalism in the full and complete manner proposed, the press and public are indebted to General Jos. R. Hawley, President of the Centennial Commission, himself a newspaper man of large experience and advanced views, who knows better than most men that in this particular interest the United States are not only in advance of any other country, but that they furnish more and better papers, having a larger aggregate circulation, than those of all the other nations of the world combined.

The applications for space in the main building have been so numerous and so far beyond the anticipations of the Commissioners, that the requests of 800 American exhibitors for space were obliged to be thrown aside, after 3000 had been accommodated in the United States department. In view of these demands, the Board of Finance has just decided to erect four annexes to the main building. The contracts have been awarded. The four new buildings will be each 150 x 50 feet, situated along the southern side of the main building, and constructed in the general style of that edifice.

Nature herself seems to aid the Centennial. But for the open winter the great works pushed forward to completion in Fairmount Park would now be in a backward condition. The landscape gardening, the transplanting of trees and shrubbery, the general preparation of the ground, and the work of building, have all been favored by the unusually mild weather of the year we celebrate.

Dom Pedro, Emperor of Brazil, will come in the steamer Maskelyne, one of the finest vessels of the Buenos Ayres and Liverpool Line, commanded by Captain Edward Hairly, a nephew of Lady Franklin. The royal party will embark at Rio Janeiro, and proceed direct to New-York in the latter part of May or early in April. The Emperor has eighteen months' leave of absence, and his daughter presides as Regent during his absence.

The total area covered by the Centennial buildings proper will be about seventy-five acres, which is nearly double the space covered by the buildings at the Vienna Exposition.

The Italian deputation consists of Chevalier Angelo Padavani, President; Signor Guiseppe Dassi, Vice-President; Professor Emanuele Carone, Chevalier M. Papotti Cantalamessa and Signor P. Baccarani.

It is intimated that there will be 1 [illegible]00 exhibitors in the Italian department. A fine display will be made, particularly in the Art Department, as there will be some 200 exhibits of statuary alone.

NEW BELLOWS STEAM-ENGINE.

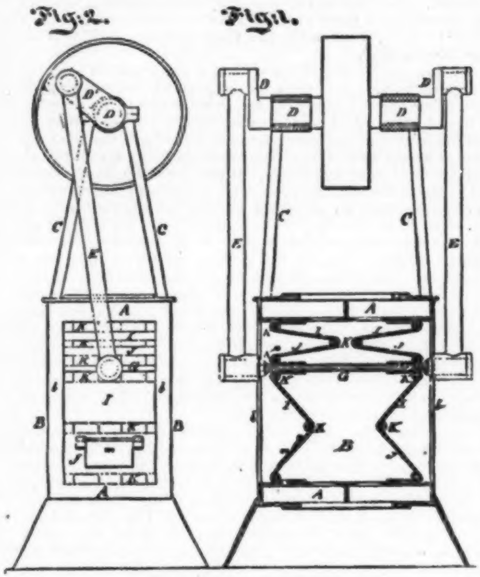
By T. F. REILLEY, New-York City.

MY engine is of the reciprocating class, which usually requires a cylinder and piston. I dispense with any parts having functions corresponding fully with those parts. My approximation to a cylinder or analogous inclosing-vessel is simply two stiff plates having their inner surfaces perfectly plain and parallel to each other. My approximation to a piston lies in a movable piece of rectangular form, extending across the space between the parallel plates, and fitting tightly to each by the aid of suitable packing, and connected to the valve-chest by means of tightly-hinged side pieces, which also extend across and fit tightly against the aforesaid parallel plates. The hinged side pieces fold and unfold in a manner analogous to the leather of a bellows, or more exactly to the stiff folding parts frequently employed in the construction of the musical instrument known as the accordeon.

On the admission of the steam to the limited space below the piston and within the folding sides, the piston is pressed upward, and the sides are caused to expand. The admission of but little steam causes a large amount of motion in the piston at this stage of the movement. Later, in the upward movement of the piston, the steam is received much faster in proportion to the movement of the piston and near the termination of the strokes. The pressure of the steam against the folding sides causes the sides to act as toggle levers to powerfully urge up the piston. In the latter portion of the stroke the steam is highly effective in three directions—upward against the piston and in both directions laterally against the folding sides. Earlier in the stroke the action against the folding sides contributes to move the piston, but in a less degree. The efficiency of the pressure against the side in urging up the piston increases as the movement of the piston progresses.

In the working of steam very expansively, the pressure of the elastic fluid varies in the reverse direction. It is very great at the commencement, and is reduced, according to certain well-known laws, as the piston moves. My invention tends to equalize the action of the engine in working steam with a high degree of expansion. The steam received at

Fig. 2. Fig. 1.



BELLOWS STEAM-ENGINE.

eighty pounds pressure at the beginning of the stroke works with little advantage. When it has been expanded until its force is nearly lost toward the close of the stroke, it still exerts a very effective action on the piston by reason of its toggle action on the folding sides.

A A, steam-chests, carrying suitable valves, with connections for operating them, which may be of any ordinary character. In water-engines I employ additional valves to aid in the exhaust. B B, parallel sides, which may be of cast-iron, smoothly finished on the inner faces, and stiffly braced with cross-webs on the outer surfaces. C C, upright frames, which support the crank-shaft D, from the cranks D' D' of which extend connecting-rods E E, which take hold of suitable bearings on the end of the stout flat piece G, which I denominate the piston. Its action is somewhat analogous to the piston of an ordinary steam-engine, but working under very different conditions, inasmuch as it fits tightly only at the sides, and its ends are free. The several folding end parts I J are of a width exactly equal to the width of the piston G. Each pair, I J, are hinged together, and also to one of the steam-chests and to the piston. There are four sets of these hinged ends, I J, arranged as represented. Two sets form the ends of the steam-space below the piston, and two similar sets form the ends of the steam-space above the piston. Packing should be employed at the edges of the piston, and also at the edges of the parts I J. The joints or hinges K should also be tightly packed or formed, so as to not only be tight when new, but to allow of being set up or tightened to compensate for wear. The piston may be guided by inclosing its corners within the corners *b* of the side pieces B, as shown, or by any other suitable means.

When my engine is used as a water-engine, operating, for example, by the force of water in a pipe at the foot of a mountain, it is desirable to provide an unusually liberal passage for the escape of the fluid immediately on the completion of the stroke. The rapidity with which the folding sides are pressed inward during the early portion of the return movement of the piston, renders this more necessary in my engine than with any ordinary style. I get over this difficulty by providing extra exhaust-valves, *m*, mounted in the lower portions J of the hinged ends. These valves are worked by suitable connections (not represented), so that they widely and promptly open at the commencement of the return stroke, and remain open during the whole of the return movement. They then close tightly, and the mechanism lies flat, so as to offer no impediment to the folding of the parts I and J together. The ordinary valves at the top and bottom may be slide or puppet valves, worked in the ordinary manner, and providing only the ordinary openings.

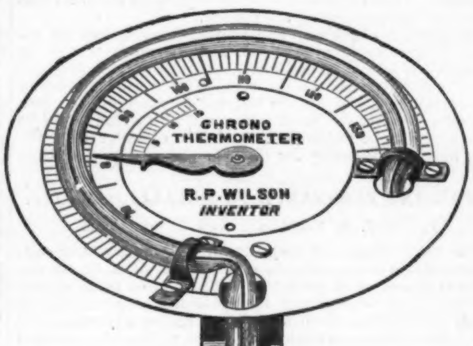
CHRONO-THERMOMETER FOR TESTING MINERAL OILS.

By B. REDWOOD, F.C.S.

IN the testing-room of the Petroleum Association, London, it is the invariable practice to raise the temperature of the oil at the rate of 20° in 15 minutes—this being, in the opinion of those who have been consulted by the association on the subject, a fair and proper interpretation of the spirit and letter of the law. The time is noted when each sample of oil under examination reaches a temperature of 70°, and the lamp is so regulated that the oil arrives at a temperature of 90° in a quarter of an hour, this rate of heating being maintained until the termination of the experiment.

Such regulation involves constant reference to the watch or clock, especially where several samples are being tested at the same time, and necessitates considerable care and attention, as well as some little skill and experience for some period before the actual testing of the oil commences.

To facilitate the operation, and, at the same time, to bring about the adoption of a uniform rate of heating, so as to minimize the discrepancies between the results of different manipulators, the little instrument represented in the illustration has been devised.



CHRONO-THERMOMETER.

It is the invention of Robert P. Wilson, and consists of a watch movement in conjunction with a circular thermometer. The watch is provided with but one hand, and the balance-wheel is so adjusted that this hand moves through 20° of the thermometer scale in 15 minutes. It is, therefore, merely necessary, in making an experiment, to set the hand when the mercury reaches 80°, and to regulate the lamp so that the quicksilver and the watch-hand travel round the dial *pari passu*. If the thermometer is observed to be getting ahead of the watch, the light under the water-bath is slightly lowered (this being easily effected by the mechanical arrangement in the wick-holder), and, of course, *vice versa*.

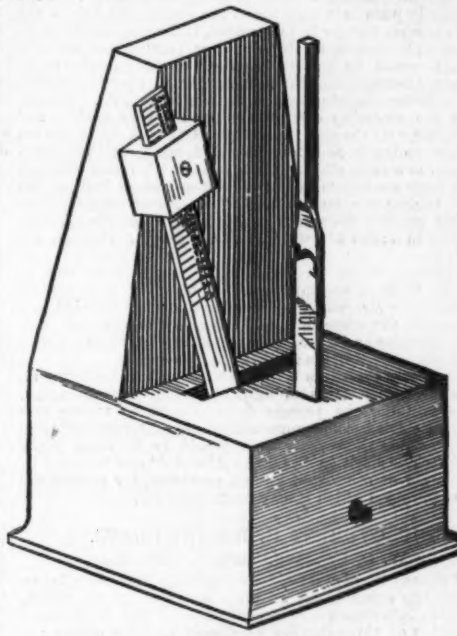
The inner line of degrees marked on the thermometer scale represents minutes (1 to 15), and the outer line, degrees of Fahrenheit's scale, 20 of which (80 to 100), it will be observed, are equivalent to the 15 minutes, though, of course, in the construction of the instrument, any other desired rate of heating may be provided for.—*English Mechanic.*

IT is said that corn loses one fifth by drying, and wheat one fourteenth. From this, the estimate is made that it is more profitable for the farmer to sell unshelled corn in the fall at 75 cents than at $1 a bushel in the following summer, and that wheat at $1.25 in December is equal to $1.50 in the succeeding June. In cases of potatoes—taking those that rot and are otherwise lost, together with the shrinkage—there is little doubt that between October and June the loss to the owner who holds them is not less than 33 per cent.

SUGGESTION FOR A MOTION-TIMER.

By J. W. SEE, M. E.

THIS is simply an adaptation of the metronome. I do not call it a speed-indicator, but a "motion-timer." A metronome is to be fitted up with a dead black background. The vibrator is to be graduated in a manner which is apparent, by means of a watch, and is to be made white, as is also the weight. The body of the instrument is to be furnished with a heavy bottom to hold it solid when seated. In front of the vibrator is erected a white upright, flexible, and provided with means of attachment to the engine, or whatever it may be, by a cord.



MOTION-TIMER.

It is often desirable in engine tests to give to the engine a certain motion and to keep it uniform. The usual process is to set the engine as near right as possible, using a counter, and at the end of the test to divide the counter by the clock, and so strike an average.

In using this "motion-timer," the weight is set at the desired figure, the machine wound up and set in motion, the cord attached, and the engine speeded so as to make the oscillations of the two vibrators isochronal. It is not necessary that the motions should be coincident, as the eye readily accepts the crossing of the two.

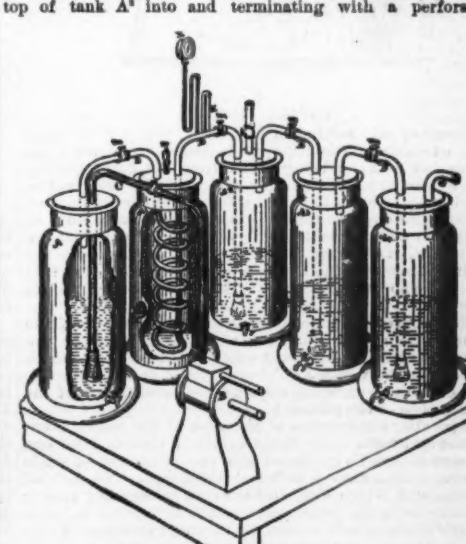
The metronome can be bought in any music-store for five dollars, and the alterations made easily. No patent.

AGEING OF DISTILLED SPIRITS.

By S. SWEET, JR., Boston, Mass.

THE object is to purify and give to newly-distilled spirits the qualities which heretofore have only been attained by long keeping, or by transportation in vessels making long voyages at sea.

A, A^1, A^2, A^3, A^4, tanks, two feet in diameter, six feet high. B, air-pump. C, pipe leading from air-pump into and terminating with a perforated enlargement near the bottom of tank A. D, pipe from the top of tank A into A^1; thence in a coil to bottom; thence upward through the top into and terminating with a perforated enlargement near bottom of tank A^2. E, pipe from top of tank A^2 into and terminating with a perforated



APPARATUS FOR AGING LIQUORS.

enlargement near bottom of tank A^3. F, pipe from the top of the tank A^3 into and terminating with a perforated enlargement near bottom of tank A^4. G, pipe from the top of the tank A^4, opening into the atmosphere at any convenient distance from the tank, for the egress of the air after it has passed through the several tanks mentioned. H is opening in the tank A^1, with a connection for attaching a steam-pipe, for the purpose of introducing steam into that tank to warm the air in the pipe D. K, thermometer, with bulb within the pipe D. L, pressure-gauge. M, check-valves, allowing the passage of air from the air-pump through the several tanks, but preventing a return current. N, safety-valve.

The tank A is partly filled with water, say about two thirds

full. The tank A^2 contains no water or other liquid, but only the coil of the pipe D, and is intended to receive steam through the opening H, for the purpose of warming the air passing through the coil in it. The tank A^3 contains the spirits to be treated, being filled from half to two thirds full. The tanks A^3 and A^4 are filled from half to two thirds full of water.

The air-pump is put in motion and a sufficient amount of steam admitted to the tank A^1 to heat the air in the coil-tube D so as to raise the mercury in the thermometer to about 140°. The air being forced through the pipe C is disseminated through the bottom of the water in the tank A, rising through it into the open space in the upper part of the tank, the water arresting and holding the floating matter and impurities which the air contained before entering it, thus leaving the air perfectly pure as it rises above the water. As this is the most important feature in the process, if there is any doubt as to the complete purity of the air after passing the water in tank A, it would be best to introduce another similar tank, with water between the tanks A and A^1, to give it a second washing before entering into the spirits in tank A^2. The action of the air-pump continuing, the air thus washed and purified is forced through the coil-pipe D in tank A^1, the steam therein warming it, as before described, and is again disseminated in the bottom of the spirits in tank A^2, rising through it with force enough to give it the appearance of boiling, but in fact raising the temperature of the spirits very slightly, and after passing the spirits the air is again driven through the water in tanks A^3 and A^4, thence escaping through the pipe G.

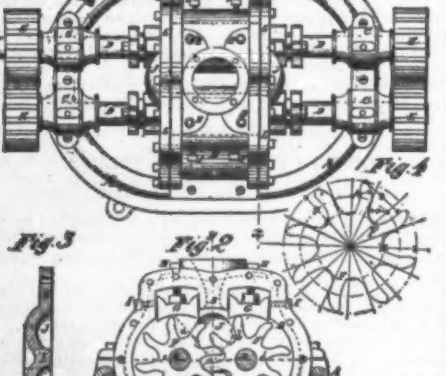
The passage of the air through the spirits in the tank A^2 keeps the fluid in constant agitation, bringing it in contact with the pure air, which takes up and carries forward into the water in the succeeding tanks the volatile oils and such other impurities as it is capable of taking up, together with a small percentage of the alcohol.

The water in the tanks A^3 and A^4 arrests and holds the alcohol and other matters brought by the air from the spirit. After continuing the process from sixteen to twenty-four hours, the spirit becomes pure and wholesome, and mellowed and ripened as thoroughly as it would be by many years' keeping. The spirit in the tanks A^3 and A^4 can be saved by redistillation or other well-known processes, for mechanical or other purposes which it may be suitable for.

IMPROVEMENT IN ROTARY PUMPS.

By W. O. CROCKER, Turner's Falls, Mass.

THE pistons F are constructed as follows: A circle is drawn of a diameter equal to the required diameter of the piston, and within it is drawn a concentric circle of half its diameter and another of three fourths its diameter. The circles are then divided into sixteen equal parts by radii. From the points of intersection of each alternate radius, with the intermediate circle as centres, and with a radius equal to the dis-



ROTARY PUMP.

tance apart of said radii upon said circle, is struck the inner part of one side of the teeth, as indicated by arrow 1, the outer part of said side being struck from the corresponding point of the next alternate radius, and with the same radius as the last arc. From the intersection of the arcs last drawn with the outer circle as centres, are struck the other sides of the adjacent teeth, as indicated by arrow 3. The pistons are made of such a diameter that their teeth or wings can not come in contact with the inner surface of the case B, so that there can be no grinding and friction between said pistons and case.

In the walls of the case B, upon the opposite sides of the discharge-opening in said case, and directly opposite the shafts D, are formed chambers extending the entire length of the case B, in which are placed blocks or abutments G, the inner surfaces of which are concaved upon the arc of the circumference of the pistons F.

The peculiar construction of the teeth of the pistons F enables the said teeth to be made so small that at least one tooth may always be in contact with each abutment G, while at the same time having sufficient water-space. To each of the abutments G are swivelled the forward ends of two or more set-screws, H, which pass in through screw-holes in the walls of the case B, so that by turning the screws H the abutments G may be set up to take up wear, and may be adjusted at any desired closeness to the pistons F. The abutments G are set up against the sides of their chambers next the discharge-opening by two or more set-screws I, which pass in through screw-holes in the walls of the case B, and rest against the sides of said abutments farthest from the said discharge-opening.

By this construction the shafts D are relieved to a great extent from the pressure of the water. The said pressure, being between the abutments G, can not so press the shafts as to bring the pistons F into contact with the inner surface of the case B.

A vent-chamber, J, and a suction-chamber, K, are formed in each head upon the opposite sides of a line joining the shafts D, to allow the water to pass out of and into said spaces freely.

The dotted lines *a b* of Fig. 2 illustrate the area and direction of pressure, while those marked *c d* exhibit the result of placing the blocks opposite to each other. The sum of the lines *a b* is less by a third than that of lines *c d*, indicating a reduction of pressure on the piston in the same proportion by the arrangement of my blocks over that sometimes employed. This is an important matter in large power or water or fire pumps, where the dimensions of piston are often twelve inches in diameter by the same in length, being exposed to a pressure of one hundred pounds to the square inch; hence my arrangement lessens wear of bearings, and saves much power. Another point in the arrangement of these blocks is their location above the pistons, and in a direction contrary to the tendency of drift in the pistons. This prevents the latter from coming in contact with the blocks, and is an advantage which can not be produced by any other arrangement of the blocks.

It will be observed that these blocks are provided with an adjusting screw, by which they are moved very close to, but not in contact with, the pistons, to prevent the parts from grinding together and producing wear, while the check-screws in the sides of the chambers are necessary to force the blocks tightly against the walls of the exit, to prevent the air from passing over the blocks and into the pipe, as well as the blocks themselves from vibrating, so as to get out of adjustment. I thus render the blocks adjustable in both directions, and independent of the pistons.

The function of the vent and suction-chambers can be understood by supposing the pistons under water, so that as the tooth of one enters a cavity of another, the water is forced out of the latter, and as the same tooth leaves the cavity there is an ingress of water; but the entrance of the tooth will cause some of the water to flow out at the end, while its departure will be followed by an inflow of water from the end; hence the necessity for the vent and suction-chambers.

IMPARTING RESONANCE TO METALLIC ALLOYS.

By PROF. B. SILLIMAN, New-Haven, Conn.

WHATEVER degree of resonance or ring the ingots or casts of these alloys may possess is entirely destroyed by the mechanical processes of rolling or lamination of spinning and striking up, by which means the products of this industry are chiefly brought into the desired forms during their manufacture. Many attempts have been made to impart a musical quality or resonance to wares made of metallic alloys known as britannia, pewter, and white metal, and composed of tin or other soft metal hardened by antimony, copper, zinc, and the like, by changing the proportion of their ingredients, and otherwise, but hitherto, without success.

My process consists in submitting such articles, whether formed by the processes of rolling, spinning, or otherwise, to the action of a regulated and well-determined temperature, just short of their melting-point, for a brief but measured time. By this simple process all vessels of capacity, of whatever form or dimension, and all other articles of the class of metallic alloys named, are endowed with the musical quality so justly esteemed, but hitherto wanting in these wares.

In carrying out my invention, I provide a bath or vessel of capacity sufficient to accommodate the largest articles to be treated. This bath may be filled with either paraffine or a heavy mineral oil, freed in its manufacture from all the lighter oils of low boiling-point, and capable of withstanding a temperature of at least 500° Fahrenheit without boiling.

The temperature of this bath must be raised to about 220° centigrade, or 428° Fahrenheit, and then more gradually to about 230° centigrade, or 446° Fahrenheit—that is, just below the melting-point of britannia, which will be found to vary as produced by different makers.

In practising my invention, the bath should be kept within, say, 10° Fahrenheit of the melting-point of the alloy, and the articles to be treated immersed therein for a brief time, which will vary with the size and weight of the articles treated.

The time requisite for the treatment of such articles as are bathed on only one surface may be somewhat longer than when the immersion is total. The rapid cooling of the articles after they are withdrawn from the bath makes no difference, either with their musical resonance or their stiffness, both of which qualities are equally produced by allowing the articles to cool slowly or quickly.

If any portion of the objects thus treated fail of being brought up to the proper crystallizing temperature the resonance of the articles is greatly impaired; such uncrystallized parts failing to vibrate in unison with the rest, a discord is produced. Articles thus treated by my process lose part of the density imparted by the mechanical pressure of rolling, etc., but do not become porous like the cast articles. They also acquire a sensibly increased stiffness or temper, enabling them the better to stand rough usage.

TO REFIT LEAKY PLUGS TO THEIR COCKS.

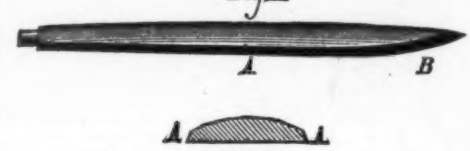
BY JOSHUA ROSE.

WHEN a cock leaks, be it large or small, it should be refitted as follows, which will take less time than it would to ream or bore out the cock or to turn the plug, unless the latter be very much worn indeed, while in either case the plug will last much longer if refitted, as hereinafter directed, because less metal will be taken off it in the refitting.

After removing the plug from the cock, remove the scale or dirt which will sometimes be found on the larger end, and lightly drawfile, with a smooth file, the plug all over from end to end. If there is a shoulder worn by the cock at the large end of the plug, file the shoulder off even and level. Then carefully clean out the inside of the cock, and apply a very light coat of red marking to the plug, and putting it into the cock press it firmly to its seat, moving it back and forth part of a revolution; then, while it is firmly home to its seat, take hold of the handle end of the plug and pressing it back and forth at a right angle to its length, note if the front or back end moves in the cock; if it moves at the front or large end, it shows that the plug is binding at the small end, while if it moves at the back or small end, it demonstrates that it binds at the front or large end. In either case the amount of movement is a guide as to the quantity of metal to be taken off the plug at the requisite end to make it fit the cock along the whole length of its taper bore. The red marking referred to is dry Venetian red and lubricating oil mixed thickly, a barely perceptible coating being sufficient.

If the plug shows a good deal of movement when tested as above, it will be economical to take it to a lathe, and, being careful to set the taper as required, take a light cut over it. Supposing, however, there is no lathe at hand, or that it is required to do the job by hand, which is, in a majority of cases, the best method, the end of the cock bearing against the plug must be smooth filed, first moving the file round the circumference, and then drawfiling; taking care to take most off at the end of the plug, and less and less as the other end of the plug is approached. The plug should then be tried in the cock again, according to the instructions already given, and the filing and testing process continued until the plug fits perfectly in the cock. In trying the plug to the cock, it will not do to revolve the plug continuously in one direction, for that would cut rings in both the cock and the plug, and spoil the job; the proper plan is to move the plug back and forth at the same time that it is being slowly revolved. As soon as the plug fits the cock from end to end, we may test the cock to see if it is oval or out of round, as follows: First give it a very light coat of red marking, just sufficient, in fact, to well dull the surface, and then insert the plug, press it firmly home, and revolve it as above directed, then remove the plug, and where the plug has been bearing against the surface of the cock, the latter will appear bright. If, then, the bore of the cock appears to be much oval, which will be the case if the amount of surface appearing bright is small, and on opposite sides of the diameter of the bore, those bright spots may be removed with the half-round scraper shown in Fig. 1.

Fig. 1



SECTION

A representing in each case a cutting edge. The scraper should be firmly fixed in a handle, and used so as to cut at about the point B. Having eased off the high spots as much as deemed sufficient, the cock should be carefully cleaned out (for if any metal scrapings remain they will cut grooves in the plug), and the red marking reapplied, after which the plug may be again applied. If the plug has required much scraping, it will pay to take a half round smooth file that is well rounding lengthwise of its half round side, so that it will only bear upon the particular teeth required to cut, and selecting the highest spot on the file, by looking down its length, apply that spot to the part of the bore of the cock that has been scraped, drawfiling it sufficient to nearly efface the scraper-marks. The process of scraping and drawfiling should be continued until the cock shows that it bears about evenly all over its bore, when both the plug and the cock will be ready for grinding.

Here, however, it may be as well to remark that in the case of large cocks we may save a little time and insure a good fit by pursuing the following course, and for the given reasons. If a barrel bears all around its water-way only for a distance equal to about $\frac{1}{16}$ of the circumference of the bore, and the plug is true, the cock will be tight, the objection being that it has an insufficiency of wearing surface. It will, however, in such case wear better as the wearing proceeds. There is perhaps the further objection that so small an amount of wearing surface may cause it to abrade. This, however, has nothing to do with our present purpose, which is to save time in the grinding, insure a good fit, and at the same time ample wearing surface. One plug and barrel being fitted as directed, we may take a smooth file and ease very lightly away all parts of the barrel, save and except to within say ¼ inch around the water or steam way. The amount taken off must be very small—indeed, just sufficient, in fact, to ease it from bearing hard against the plug, and the result will be that the grinding will bed the barrel all over to the plug, and insure that the metal around the water or steam way on the barrel shall be a good fit, and hence that the cock be tight.

The best material to use for the grinding apparatus is the red burnt sand from the core of a brass casting, which should be sifted through fine gauze and riddled on the work from a box made of say a piece of 1½ pipe 4 inches long, closed at one end and having fine gauze instead of a lid. Both the barrel and the plug should be wiped clean and free from filings, etc., before the sand is applied; the inside of the barrel should be wetted in and the plug dipped in water, the sand being sifted a light coat evenly over the barrel and the plug. The plug must then be inserted in the barrel without being revolved at all till it is home to its seat, when it should be pressed firmly home, and operated back and forth while being slowly revolved. It should also be occasionally taken a little way out from the barrel and immediately pressed back to its seat and revolved as before, which will spread the sand evenly over the surfaces and prevent it from cutting rings in either the barrel or the plug. This process of grinding may be repeated, with fresh applications of sand, several times, when the sand may be washed clean from the barrel and the plug, both of them wiped comparatively dry and clean, and the plug be reinserted in the barrel, and revolved as before a few revolutions; then take it out, wipe it dry, reinsert and revolve it again, after which an examination of the barrel and plug will disclose how closely they fit together, the parts that bind the hardest being of the deepest color. If, after the test made subsequent to the first grinding operation, the plug does not show to be a good, even fit, it will pay to ease away the high parts with a smooth file, and repeat afterwards the grinding and testing operation.

To finish the grinding, we proceed as follows: give the plug a light coat of sand and water, press it firmly to its seat and move it back and forth while revolving it, lift it out a little to its seat at about every fourth movement, and when the sand has ground down and worked out, remove the plug, and smear over it evenly with the fingers the ground sand that has accumulated on the ends of the plug and barrel, then replace it in the barrel and revolve as before until the plug moves smoothly in the barrel, bearing in mind that if at any time the plug, while being revolved in the barrel, makes a jarring or grating sound, it is cutting or abrading from being too dry. Finally, wipe both the barrel and the plug clean and dry, and revolve as before until the surfaces assume a rich brown, smooth and glossy, showing very plainly the exact nature of the fit. Then apply a little tallow, and the job is complete and perfect.

PLUMBAGO.

THE principal supply in this country is derived from the mines at Ticonderoga, N. Y. The miners are paid by the ton of prepared mineral, receiving therefor $125. The five grades of manufactured graphite are worth at present about five cents a pound for stove-polish, 15 cents for powder-polish, 50 cents for pencils, and $1 a pound for stereotype powder. The first process after the ore leaves the mines is the stamping, by which it and its accompaning rock is reduced to fine powder; it is then washed, dried in an oven, then bolted, like flour; after this it goes through a Bogardus mill, is again bolted, and then is known as crucible stock. If finer grades are needed additional processes are required.

[Engineer.]

FOG-SIGNALS.

(See illustration on page 184.)

As to the kind of sound or note that is heard furthest there is much difference of opinion; but the preponderance of evidence is decidedly in favor of a deep rather than a shrill sound. If this is correct, there is an analogy in the case of sound with that of light, for in both cases it is the slow long wave that is propagated the greatest distance. Red is the color that causes the slowest vibration, and, as any one may observe for themselves on a foggy night, all lights as they become more distant appear redder in hue, the other waves in the spectrum being absorbed and lost in greater proportion than the red. We are making no connection between the effect of fog more than any other medium in the case of light and sound, but merely calling attention to the bare fact that the slow long wave is propagated further through a resisting medium than the quick one, in the case of sound as well as in that of light.

The question of particular sounds or notes brings us to that of the instruments themselves. They are as follows: Air-horns or trumpets, steam-whistles, the siren, and guns or explosive reports, projected by various means.

Air-horns and trumpets have been for some years used on our own coasts, but had never been tried in competition with other instruments before, and were therefore tested in this investigation. The horn is a brass trumpet, 8 ft. 6 in. long, 3 in. diameter at the mouthpiece, and about 23 in. at the mouth (see page 184, Fig. 3). It has a steel "reed," 10½ in., 3 in. wide, ½ in. thick, which is adjusted to suit the fundamental note of the trumpet, and made to vibrate by air at 18 lb. pressure, Fig. 3 and Fig. 4.

Whistles are of several kinds—namely, the American, the Canadian, Holmes' and Bayley's of two sizes, C H Fig. 2. The principal size was about 12 in. in diameter; they were driven by steam at about 74 lb. pressure.

The siren, Fig. 2, is a steam-sounding instrument—it might be called a kind of steam-trumpet. The sound is caused by the passage of steam at 70 lb. to the square inch through the openings made by the revolution of one disk with radial slits cut in it in front of a similar disk fixed in the trumpet, Fig. 5. The most effective rate of rotation is from 2400 to 3800 revolutions per minute. The trumpet is of cast-iron.

Sir F. Arrow, in his report on the whole experiments, says that the whistles showed a marked inferiority to the other instruments. The Canadian was better than the American, but all had the fault of yielding a deafening roar of a local character, bearing out what we have said as to the sharp sounds not being those which are best propagated to a distance. It is reported that the sound of a whistle when upright is best heard in a horizontal plane in which it is fixed. The trumpets are better than the whistles, and their use may be at present continued. The siren, however, is by far the most powerful of these kind of instruments.* Of it Dr. Tyndall says: "It is beyond question the most powerful fog-signal which has hitherto been tried in England. It is specially powerful when local noises, such as those of wind, rigging, breaking waves, shore-surf, and the rattle of pebbles, have to be overcome. Its density, quality, pitch, and penetration render it dominant over such noises after all other signal-sounds have succumbed." Again: "What may with certainty be affirmed is, that in almost all cases the siren, even on steamers with paddles going, may be relied on at a distance of three miles, and in the majority of cases at a distance greater than three miles."

The gun even, it appears, is unable to resist the disturbing effect of other noises as well as the siren. The siren, it is fair to remark, calls for a rather greater consumption of coal and water to work it than the whistles.

It has been found—and this is again in accordance with what has been said as to sharp reports and local and propagated effects—that it is a mistake to make sounding instruments or guns of bronze or brass. The latter metals vibrate and produce a violent local ring; but the force expended in this seems to be taken from the sound wave which is projected in the desired direction, and consequently iron instruments and guns are to be preferred. For guns, however, we must turn to the paper read by Major Maitland, the Assistant-Superintendent of the Royal Gun Factories, whose province it was to take up this branch of the work. The guns having the advantage of a distinct abrupt report, which may readily be distinguished from the prolonged note of the siren, it was desirable to establish some combined system of employing them. The most complete arrangement seems to be to employ sirens on board lightships and guns on land.

The problem submitted to the gun factories was the following: "To produce the most far-reaching sound possible with a charge of 3 lb. of powder, and to enable two men to keep up the firing at intervals of not more than five minutes during a long-continued fog." To meet this case, a kind of revolving chamber loader was designed—*vide* Fig. 6. The chambers are radiating ones, 7 in. in depth and 5 in. in diameter, in a horizontal disk or wheel; the latter can be forced as tightly as required against the barrel by means of powerful screws. The joint is closed by a steel ring, somewhat on the principle of the throat-valve of a hydraulic press. There is an arrangement by which the charge is fired by an ordinary tube, which can only enter when the chamber is in the true firing position. After discussing the question of the two factors of the sound which we have referred to as applying to all signal instruments—that is, the sound consisting of the vibration of the metal, and the sound caused by the wave of air propelled forward—Major Maitland observes that the intensity of the sound caused by the firing of a gun is much greater at any spot in front of the plane of the muzzle of the piece than at any corresponding spot behind the same plane, which he attributes to a lateral wave caused by the resistance of the atmosphere to the sudden blow of the expanding gas generated by the explosion of the charge.

Major Maitland discusses the very interesting question of the best form of enlarged mouth that could be given to a gun with a view to the propulsion of sound in the direction in which the gun is pointed. For sound, as for light, the form of reflector which should project the impinging waves in parallel directions to the front, so as to form a beam of sound—if such an expression may be used—is a parabola, supposing that the waves all emanated from a point at the focus of the parabola. Since it is impossible that the vibrations impinging against the sides of the bell mouth can be generated at the focus or any other point in space, it becomes a difficult matter to decide exactly what curve is best. It appears that hitherto a conical mouth has been fairly successful, but it is apparent that some nearer approach to the parabola will eventually prove the best. Fig. 7 exhibits the section of guns of various forms of mouth that have been tried—namely, cast-iron plain gun, cast-iron large cone, cast-iron small cone, and parabola. In addition to the gun-signals, charges of gun-cotton were exploded with and without sound-reflectors. The general results were as follows with charges of 4 oz:

Signal Instrument.	Relative Order of Merit and range in yards. 100 to 1800	1900 to 4400	5000
Plain gun	5	6	5
Large cone	4	4	6
Small cone	3	5	4
Parabola	6	3	3
Gun-cotton in reflector	1	1	1
Gun-cotton in open	2	2	2

From this it appears that up to 5000 yards range the report of 4 oz. of gun-cotton is invariably more distinct than that of the same charge of powder. As, however, the comparison between equal weights is hardly a fair one, for there is no special limit as to quantity, and the question being more one of cost of material expended, subsequent experiments were made with charges of equal price, and on a larger scale and at longer distances. On May 2d, at two and a half miles range, the results of seventeen series were as follows:

Means used to signal.	Order of Merit.
Bronze 12-pounder howitzer, 3 lb. powder, L. G.	1
Cast-iron 24-pounder " 3 lb. " "	2
Cast-iron 18-pounder gun 3 lb. " "	3
Gun-cotton in open, 1 lb.	4
" " 1½ lb.	5

Thus it appears that the guns and powder beat the gun-cotton. There are two possible causes for this, both, however, of the same general nature, so that it is less important to distinguish between their effects: one the increase of range, the other the fact that the observers were stationed considerably to the windward. The gun-cotton explosion is—as pointed out by Mr. Abel, who suggested its trial—very sharp and well heard within a certain distance, but like the higher pitched sounds of the whistles, it is not propagated to so great a distance as the report of the gun. It is, in fact, intense but local in its action. That the report of 1 lb. should have been estimated as louder than that of 1½ lb. is to be explained by the fact that there was but little difference, and so it was possible to make an error in judgment. The brass gun, on this occasion, beat the iron, which has been attributed to the calibre of the 24-pounder being too large for the charge to have its maximum effect, a suggestion which may or may not give the correct cause.

Eventually seventeen series of signals were estimated from the following pieces:

Signal-gun and Charge.	Relative Order of Merit.
Cast-iron parabolic, with papier maché wad, 4 oz.	1
Bronze 12-pounder mortar, with wood plug, 5 oz.	3
" " " with junk wad, 5 oz.	2

In this case, the sound of parabolic gun was invariably the most powerful, and was so estimated by every observer. So that we are brought to prefer this form of mouth and the metal iron to bronze.

The following explanation of the parabola not giving the best results at short ranges, is suggested by Major Maitland. If the charge is not fired exactly at the focus, the waves of sound leave with a wider spread than in the case of the close muzzle, although their angle of dispersion is less: hence, at a certain distance, the sound of the plain gun, though more intense at first, has become more widely dispersed, while the body of that of the parabolic gun is travelling much more nearly in the desired direction.

We can hardly conclude better than by giving a sketch Fig. 1, of a pattern of revolving signal-gun, with parabolic trumpet-mouth, just completed in the Royal Gun Factories, which we suppose we may look upon as Major Maitland's design. A is a kind of lock, B the vent, C C the chambers. This gun has, we believe, been fired, but its powers as to sound have not yet been tested.

Captain Cumins Richards, R.N., of the Hydrographic Department, has proposed the adoption of a code of fog-signals, by which distinct information of a simple character may be exchanged between ships and with the shore.

* We regret that our cotemporary should have failed to state that the whistle, the trumpet and the siren which have been adopted by the British Trinity House are all American inventions.

[Boston Advertiser.]

OUR PRESENT POPULATION.

WHAT THE STATE ENUMERATIONS OF 1875 SHOW.

IT has been assumed, too hastily we think, that the growth of the country in population has received a serious check. This conclusion is based on the returns of a part of the censuses taken last year. We have not seen anywhere a table containing the results of all the enumerations, and we have endeavored to supply the deficiency. So far as known there were eighteen States that took a census of their population during the year 1875. One other made an enumeration in 1874. Of the whole fourteen, eleven are supposed to be trustworthy, and three are not so. The census of Texas is an estimate so far as it is supposed to give the total population. A school census was taken, and the figures below are based upon the result of that, corrected by a comparison of the votes at different elections. In Louisiana the object of the census was to prove that there was a large excess of colored over white people, and it is needless to say that the figures give the desired result. A note added to our return of the census in South-Carolina reports that no dependence is to be placed on it, as there was a very bad set of enumerators, and that the figures are at least 15 per cent too high. These are the Southern enumerations that have been taken since the national census of 1870. The return for Michigan is that for the year 1874, so that it represents one year less of growth than in the other cases:

	1870.	1875.
Iowa	1,194,020	1,350,544
Kansas	364,399	528,437
Louisiana	726,915	857,039
Massachusetts	1,457,351	1,651,902
Michigan	1,184,059	1'334,031
Minnesota	439,706	599,891
Nebraska	122,993	246,280
Nevada	42,492	52,540
New-Jersey	906,096	1,014,502
New-York	4,382,759	4,705,208
Rhode-Island	217,393	258,239
South-Carolina	705,606	823,447
Texas	818,579	1,275,000
Wisconsin	1,054,679	1,236,599

The annual growth of Iowa from 1860 to 1870 was 52,011 persons; from 1870 to 1875 it was 31,305. The growth of Kansas during the decade averaged 25,719 persons each year; during the last five years it has been 32,808 persons each year. Massachusetts had an average growth of 22,628 in the former period; of 38,910 in the latter. Michigan had an annual increase of 43,495 in the earlier period, and of 37,493 in the years from 1870 to 1874. Minnesota's annual growth from 1860 to 1870 was 26,768; from 1870 to 1875 it was 32,037. Nebraska's annual increase during the earlier period is not known, but during the last five years it has more than doubled its population, so that its increase must have been several times as large. Nevada was admitted in 1864, and its population in 1860 is not known. New-Jersey's annual increase from 1860 to 1870 was 23,406; during the last five years 21,681. New-York received an annual accession of 50,202 during the earlier period, of 64,490 during the latter. Rhode Island added 4085 annually during the earlier period, 8170 during the latter. Wisconsin added 27,879 annually during the ten years, 36,386 during the five just ended. Rejecting the returns from the three Southern States, we see that the absolute rate of growth was not on the whole diminished. The relative rate was not far from stationary. Thus the growth of New-York in ten years was about 13 per cent; in the last five years it was 7.3 per cent on the population in 1870. In a few cases only has there been a loss in the rate of absolute growth, but the percentage reckoned on the higher basis does show only a narrow margin of increase. Undoubtedly the States that are reported are rather better than average specimens, but we do not believe that, on the whole, the check our growth has received is perceptible, taking the country at large. The eleven States whose returns are worth any thing show a growth of 1,612,000 in five years. As they represent slightly more than one fourth of the whole country, it is safe enough to estimate that the increase during the last five years has been five millions, making our total population in the middle of 1875 something more than forty-three millions.

CENSUS OF NEW-YORK STATE.

A SMALL pamphlet has recently been issued by the State Government, showing comparatively the results of the State Censuses taken in 1845, 1855, 1865 and 1875. It refers to population alone. In the year 1875 the total foots up to 4,705,208, of which number 2,277,859 were living in the twenty-four cities of the State, and 2,427,349 in the rural districts. The number of voters was found to be 1,138,330, of whom 743,682 were native born and 395,248 foreign born.

The urban and rural populations, under the four censuses contained in the pamphlet, compare as follows:

	Urban.	Rural.	Total.
1845	622,585	1,981,910	2,604,495
1855	1,190,188	2,274,930	3,466,118
1865	1,464,473	2,367,278	3,831,751
1875	2,277,859	2,427,349	4,705,208

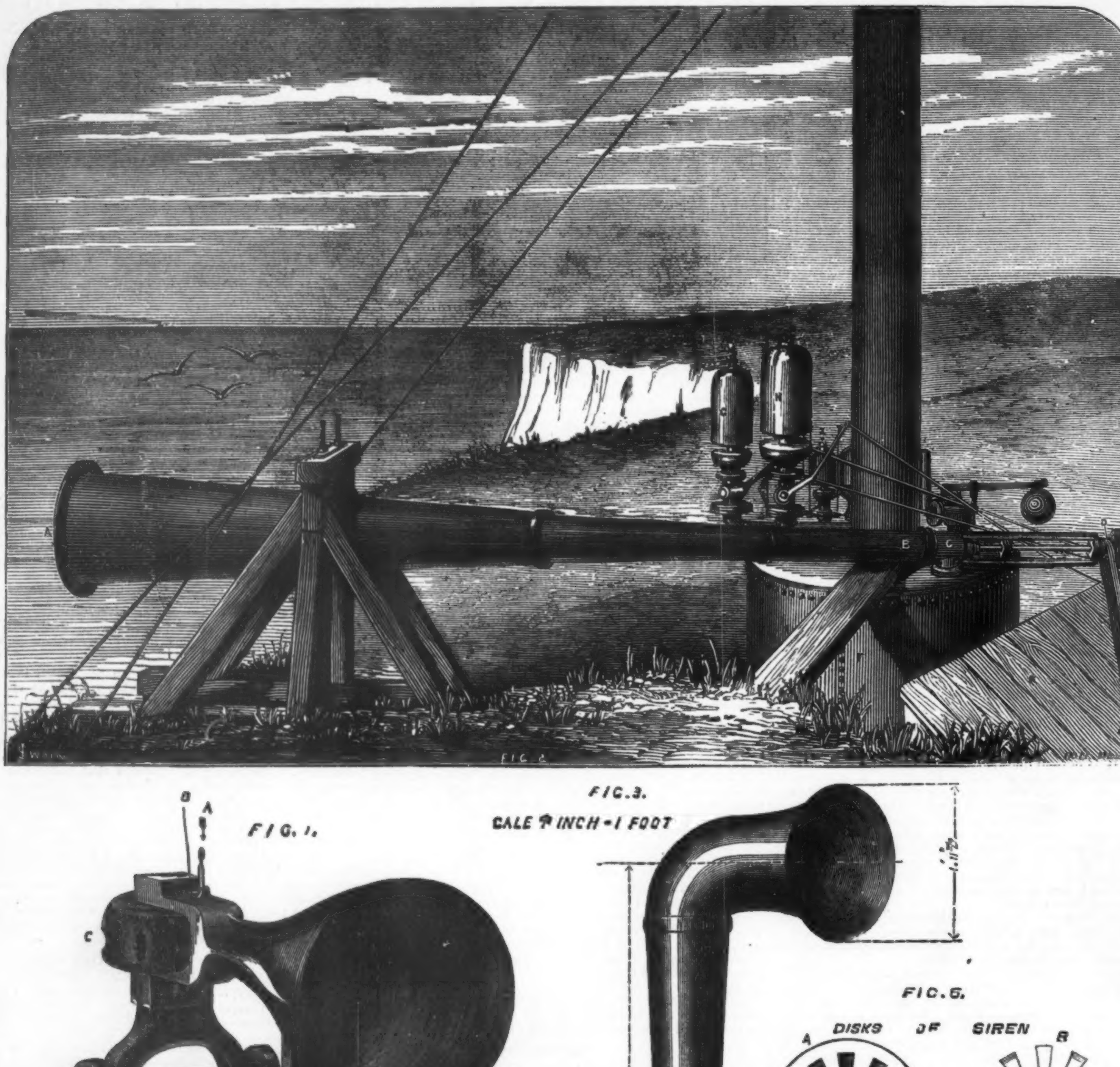
From this it appears that the urban population is rapidly increasing in proportions, or, in other words, our cities are growing more vigorously than the country parts. In 1845 the proportion of the urban to the total population was 23.9 per cent; in 1855, 34.3 per cent; in 1865, 38.2 per cent, and in 1875, 48.4 per cent. Thus in thirty years the proportion of urban population has more than doubled. The reason of this is obvious. The immigrant farmers that have entered our great port, New-York City, by hundreds of thousands during the period covered by these figures, have passed westward, attracted by the cheap and fertile lands beyond our borders, while the cities of the State of New-York prosper as their business agencies and factors, or collectors and distributors of the commercial materials produced or consumed by them. All these cities are located on the lines of commerce on the edges or through the interior of the State, and almost wholly on the great lakes and rivers. And all have the benefit more or less of the magnificent system of canals and railroads which intersect the State, and converge towards the great seaboard city at the mouth of the Hudson.

POPULATION OF CITIES, NEW-YORK STATE.

Cities.	1845.	1855.	1865.	1875.
New-York	371,223	629,810	726,386	1,046,037
Brooklyn	59,574	205,280	296,112	484,616
Buffalo	29,773	74,214	94,210	134,573
Troy	62,338	79,234	88,210	105,053
Albany	42,139	57,333	62,613	86,613
Rochester	26,965	43,877	50,940	81,673
Syracuse	....	25,107	31,784	48,315
Utica	12,190	22,169	23,686	32,670
Oswego	....	15,816	20,910	22,455
Elmira	....	....	13,130	20,538
Kingston	....	....	....	20,474
Poughkeepsie	....	12,763	16,073	19,850
Cohoes	....	....	....	17,516
Newburg	....	....	....	17,327
Yonkers	....	....	....	17,269
Long Island	....	....	....	15,609
Binghamton	....	....	....	15,550
Auburn	6,171	9,476	12,567	15,359
Schenectady	6,555	8,389	10,685	12,748
Lockport	....	....	....	12,624
Rome	....	....	....	11,922
Ogdensburg	....	....	....	13,204
Watertown	....	....	....	10,041
Hudson	5,657	6,720	7,831	8,823

FAST-WALKING HORSES.

THE London *Field*, in an article upon the forthcoming American Centennial, says: "We sympathize with their determination to give prizes for fast-walking horses. Many of the best judges of horseflesh that these islands have produced were of opinion that if a horse could walk well, he could do all things well. When Teddington, Aphrodite, Breba, The Ban, and Confessor were all yearlings together at Leybourne Grange, Sir Joseph Hawley's stud groom, Tweed, told his master that Teddington would prove 'the pick of the basket,' as he could outwalk all the others. Fobert, the trainer of the Flying-Dutchman and Van Tromp, was always a great believer in fast-walking race-horses. Every hunting man who has had occasion to jog home at night for twenty miles upon the back of a tired hunter, is aware what a blessing it is to bestride a good walker and sprightly trotter, instead of an animal 'who kicks a sixpence before him at every step.' Nothing is better known than that proficiency in certain gaits is not less hereditary in horses than are distinctive types of features in human families. Touchstone and Orlando, the grandsire and sire of Teddington, were themselves famous walkers, and if the prizes for walking distributed at Philadelphia tend to draw the attention of English breeders to the development of excellence in this gait, the Centennial will not be held in vain. Be this, however, as it may, a vast majority of the British people watch the recurrence of the hundredth anniversary of American Independence with cordial interest and satisfaction; nor can it be doubted that the contingent of visitors sent this year by England to Philadelphia will far surpass the aggregate contributed by all other civilized nations."



ACOUSTIC FOG SIGNALS.—(*See page* 183.)

LESSONS IN MECHANICAL DRAWING.

By PROF. C. W. MACCORD, Stevens Institute.

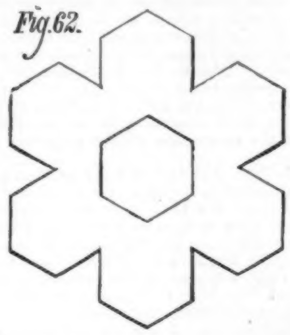
LESSON VI.

(Continued from page 134.)

WE have before alluded to the forms of the snow-flakes, as affording pleasant and instructive exercises in the use of the few articles which we shall still assume to be the only ones at hand.

Complicated as some of these forms appear at a careless glance, closer examination shows that they are characterized by a sublime simplicity of detail, no less than by exquisite

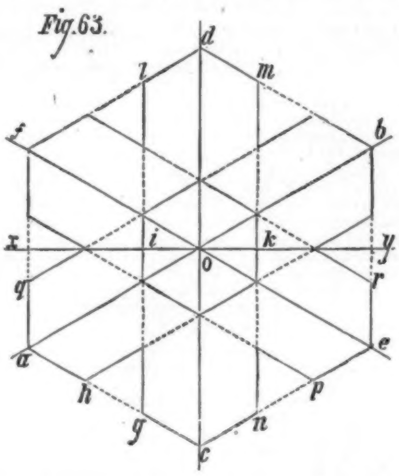
Fig. 62.



symmetry of outline and proportion; which are combined in such a degree of perfection that the human eye and hand, however skilled and dextrous, can but feebly imitate these beautiful designs.

Such imitations as can be made, however, are peculiarly appropriate for our purpose, from the nature of the elements into which the designs can be resolved; for the most intricate as well as the simplest of them are composed of straight, needle-like crystals, forming with each other angles of 30°, 60°, and 120°. This invariable law governs the crystallization of water under all circumstances, as may be seen by examining the frost-work on the windows, or, on a larger scale, by watching the formation of the first film of ice on the surface of water undisturbed by wind. The snow-flakes are of course too minute for the unaided eye to note their confor-

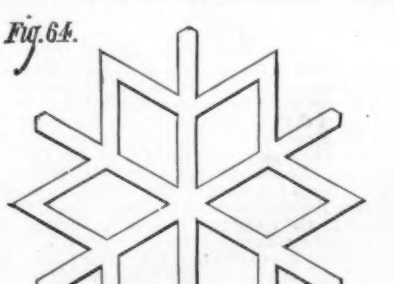
Fig. 63.



mation, but by means of the microscope their beauties have been revealed and recorded: the examples which we present are copied, much enlarged, from the very fine collection given in Deschanel's Natural Philosophy.

Inasmuch as they are symmetrical about a central point, it will at once occur to those familiar with the use of the compasses, that they might be most readily constructed by the aid of that instrument, since many of the points could be quickly and accurately determined by subdividing circles. But we again remind the reader that it is not our present object to indicate the readiest mode, nor even the most reliable or precise mode, of executing the designs presented; those who have other instruments may of course use them, but we

Fig. 64.



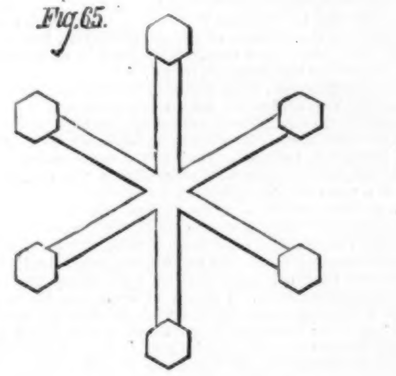
wish to show those who lack them that the deficiency is not by any means an absolute bar to progress, or even such as to prevent their making in a very satisfactory manner a great variety of drawings; and to give them abundant and attractive examples within the range of their resources.

It must not, however, be inferred from this that it makes no difference how we set about constructing these or any other drawings; for we do wish to point out the most reliable and precise mode of using the instruments at hand; and the fact that others might be better for the purpose, is no reason for using these in a careless or faulty manner, or for being content with any thing less than the best results that can be attained by their aid alone.

Now, it would be difficult if not impossible to give any set rules, or certain order of procedure, which should be applicable to all cases. Still there are a few general principles, of very extensive application; but these will be probably best learned inductively, from a few special cases—the reader who perceives the advantages of the methods explained in connection with them, will hardly fail to see the reason of the superiority to other methods, and will, we have no doubt, be able thereafter to make such modifications as may be required in other cases as they present themselves. For instance, in Fig. 62 we have the form of a snow-flake, which is composed substantially of three broad bars, of equal breadth, bluntly pointed at the ends, crossing each other at angles of 60°. Fig. 63 gives in detail, on a larger scale, the methods of construction. The first step is to draw through the centre of form, o, the three *indefinite centre lines*, ab, cd, ef, at the angles mentioned.

This expression, "indefinite centre line," is one which will be employed so frequently that it is worth while to say a few more words about it. In drawings, more particularly of mechanical objects, it will in most cases be seen, on inspection, that there are certain lines, usually imaginary, about which some portions of the drawing are symmetrical. Borrowing familiar illustrations from machinery, a connecting rod, a shaft, a bolt and nut, are in their representations symmetrical about an imaginary axis; which we call a centre line. And although in the finished drawing we may not desire to introduce it, in the construction of the figure we draw

Fig. 65.

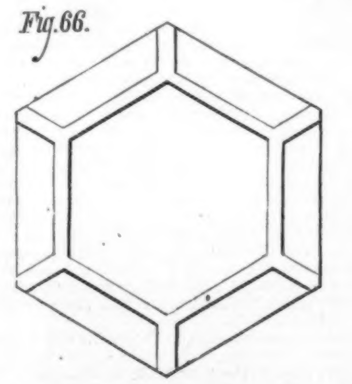


it the very first thing, in order that, by measuring from it, we shall insure the symmetry of the outlines with respect to it. It may be explained that in working drawings these centre lines, being as necessary to the mechanic as to the draughtsman, are inked in, being distinguished from the outlines in some conventional way, usually by drawing them of a different color.

And this imaginary centre line being in no way a part of or limited by the body represented, may be extended indefinitely, and in a drawing *should* be carried beyond the outline, for the express purpose of indicating that it is not a representation of any actual line in the object itself, but is placed there merely to indicate location; hence the term "indefinite" as applied to it.

Now, the sides of each of the three bars which compose our figure are parallel to and equidistant from its own centre line. And in working from this line, in drawing, for instance, the vertical bar, the usual mode would be to draw through o the line xy perpendicular to cd, and on it set off oi equal to ok, half the breadth of the bar; next to draw through i and k the sides lg, mn, parallel to cd, and set off the equal distances il, ig, km, kn; then to set off od equal to oc, each of these being in this case greater than il, and to complete this bar by drawing cg, cn, dm, dl. Each of the other bars being drawn in the same way, the figure would be finished; and no fault is to be found with this mode of ope-

Fig. 66.



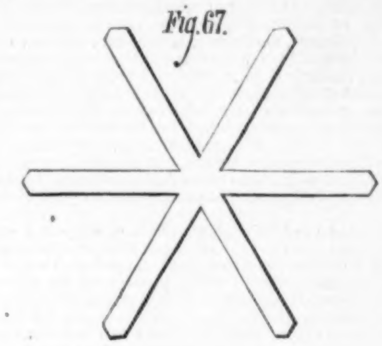
rating, if all the measurements be correctly made. We have described the process thus at length, because it involves a general rule in construction—that is, that points which are symmetrically disposed about a centre line should be set off on a line perpendicular to it, as i and k on xy. But this particular example will serve to show that there are exceptions to all rules; as all the bars are of equal length, and all the end lines, as ld, dm, cn, etc., make angles of 60° with the centre lines, it will be seen that if the former be produced, the adjacent ones of adjacent bars will coincide—as gc, for instance, is a prolongation of ah; thus the figure is bounded by a regular hexagon, as shown in dotted lines.

We may therefore, in this instance, work more advantageously thus. First set off the distances oa, oc, ob, etc., and draw the hexagon; then set off oi perpendicular to cd, and mark the point g in which a parallel to cd through i would cut ac (for which purpose, it is only necessary to set the triangles, but *not* necessary to draw the line). Now mark on the paper slip the distance ag, and set it off from c to h, from c to p, from e to n, from f to q, and from b to r; then by drawing through g and h lines parallel to ab, that bar will be finished, and so on. By this method of proceeding, in the first place, fewer measurements have to be made; in the next place, the most of them are larger, and it is to be observed that, as a general principle, the chances of error are equal in setting off any distances, while the *proportionate* error is less

the greater the distance; and, finally, we have an excellent check on the ultimate result, because knowing that a hexagon ought to bound the figure when done, we have made sure that it shall by drawing it first.

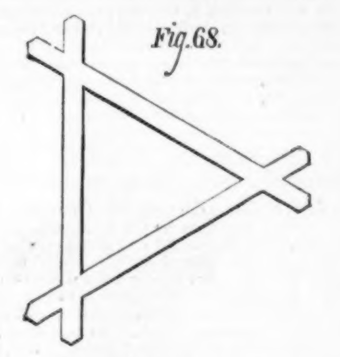
This latter circumstance is particularly to be noted; it is very clear that in proceeding as at first explained, the result of errors in measurement would have been, that ah when prolonged would not coincide with gc, for instance. There is of course no sort of rule by which such checks can be made, but we have been thus minute for the purpose of impressing upon the reader the advantage of doing it when it can be done; he should accustom himself to study his plan

Fig. 67.



before he draws it, and exercise his ingenuity in devising these tests or checks, which very often will be the means of detecting an error in time to remedy it, if not of preventing it altogether. It may be added, that the study of the relations which exist among lines when prolonged, as in this example, is a very fruitful one; it does not always, but it does very often, lead to a means of testing the accuracy with which the lines have been drawn. Another hint may be of service: form the habit of criticising your own work, and especially of scrutinizing it closely with reference to symmetry, where symmetry should be found. For example, the sides of these three broad bars, by their intersections, should form a central regular hexagon, surrounded by six little triangles, equilateral and of the same size. The eye can soon be trained so as to detect at a glance any irregularity in the hexagon or any inequality in the triangles, and when it is trained, few if any faults in drawing are more offensive to it than false preten-

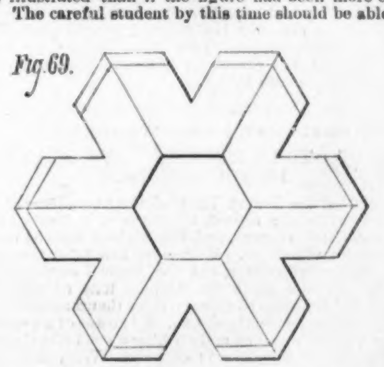
Fig. 68.



sions to symmetry. And it is to be remarked, with reference especially to working drawings of machinery, that the centre lines are standing challenges to scrutiny in this very particular, and the greatest care should be taken that they deserve their name. Finally, the original centre lines of this figure, ab, cd, ef, should also be the diagonals of this central hexagon—should pass exactly through, not near the intersections of the sides of the broad bars; nor should the novice be contented, if he has once undertaken to draw it, until he has done it in such a manner as to satisfy all the conditions named.

The remaining figures given in connection with this lesson are additional examples of the forms of snow-flakes, which we present as subjects for practice. We have purposely selected one of the most simple of these for detailed explanations, because the principles involved could thus be more clearly illustrated than if the figure had been more complicated. The careful student by this time should be able to go

Fig. 69.



alone to some extent; he must recollect that, in the nature of things, it is not practicable, nor would it be to his advantage to do so if it were, for us to mark out his path for him step by step in every instance. Such a course would tend to cripple the powers which we wish to strengthen—he must learn to analyze for himself problems as they may arise, for he will find that they will present an infinite variety.

The general principles and modes of operation which have been already pointed out will be found sufficient, with the aid of a little energy and industry on his part, to enable him to draw, and we hope in a satisfactory manner, the examples herewith given; we add the hope that he will not consider that manner satisfactory, until its results stand the application of all the tests that his ingenuity may devise.

(To be continued.)

DIPHTHERIA.

In a recent lecture by Prof. J. Solis Cohen, M.D., he remarks: "Many experienced observers consider diphtheria identical with what other experienced observers recognize as acute pseudo-membranous or true croup.

"Persons of all ages are liable to the disease, but it is much more frequent in children between the period of weaning and the tenth year of life, than in adolescents and adults. It seldom attacks individuals in absolutely first-rate health, while living under good hygienic influences, unless they have been more or less directly exposed to contagion from contact with a diphtheric patient, or with emanations from his body, whether contained in clothing, utensils, excretæ, or the exudation itself. It rather attacks individuals debilitated, or in process of debilitation from overwork, excessive mental activity, disease, abstinence, indulgence, neglect, or ochlesis; and especially such as are subject to sore-throat, acute or chronic, particularly if the mucous membrane of the throat is in part denuded of epithelium. It seems to be but little influenced by season or sudden change of weather, though damp and raw atmospheres apparently increase its liability to extend to the respiratory tract, or even to make its primary local manifestation in the air-passages proper. It is often present under morbific agencies similar to those that occasion typhoid fever, septicæmia, and other morbid processes of a dynamic character.

"There seems to be abundant reason to suspect a specific cause of diphtheria; but the nature of this cause is as yet undetermined, despite numerous experimental and clinical investigations undertaken for the purpose of its discovery. There is reason to believe that the development of diphtheria is accompanied by, if it is not in part due to, the development of atmospheric cryptogamia poisonous to the human economy, which gain access to the pharyngeal or nasal mucous membrane in the acts of inspiration, or perhaps to the pharyngeal mucous membrane or even to the epiglottis in the acts of deglutition. It must be conceded, however, that the fact that the respiratory mucous membrane itself is rarely inoculated in this way, and that the nostrils, though the main respiratory tract, are rarely primarily affected by the exudation, militates against the plausibility of this popular and fascinating theory. Once transplanted in the warm and moist nidus of the mucous membrane, it is supposed that the rapid self-propagation of the vegetable organism is facilitated, and that the poisonous germs or emanations eventually become absorbed into the blood, or make their way—by actual boring, according to some microscopists—into the lymphatic system, and thence enter the current of the circulation. Once in the blood in sufficient quantity, a systemic poisoning ensues; and this poisoning constitutes the essential element of the diseased actions that subsequently take place. One effort of the poison is the establishment of a low grade of inflammatory action in the mucous membrane, attended with the exudation, deposit, exfoliation, or slough of a fibro-plastic material, similar, as far as has been positively ascertained by microscopic and chemical observation, to the false membrane exuded in croup; similar, too, it is believed by most authorities, to the plastic exudatory slough which follows the local contact of cantharides, ammonia, hydrochloric acid, boiling water, and other vesicants.

[Virginia City (Nev.) Enterprise.]

A STRANGE SICKNESS IN ORE-MILLS.

In all the mills in which ore from the Consolidated Virginia Mine is worked, the men in the amalgamating departments are more or less affected by a new and peculiar illness. They shake as though afflicted with palsy. Their hands shake so badly that they can hardly raise a cup of coffee to their mouths. The sickness does not seem to inflict any permanent injury, as when those affected cease to work for a few days they recover their usual health. No less than ten men who have been working at the new California mill are now lying off on account of this "shaky sickness."

It is not known whether the sickness is owing to some mineral entering into the composition of the ore or whether it is caused by the chemicals. In working the ores of the bonanza bluestone (sulphate of copper), chemicals, as cyanide of potash and the like, are used in much larger quantities than when poorer ores are treated, and by some it is supposed that here lies the source of the trouble and the cause of the new sickness. The pans are closely covered during the time a charge is being worked, then when the covers are finally raised a great column of steam impregnated with chemicals and volatilized quicksilver rushes up, portions of which the men undoubtedly inhale. Except when it is storming, the windows of a mill might as well be opened as not—some of them at least—as when a mill is in operation it is always quite warm enough to allow this. One shift of men will say that they can not be bothered with the windows—that they can stand it their shift out—and so it goes, all working on as usual, and nobody looking after the ventilation. When the matter shall be properly investigated it will probably be found that the sickness among the men is caused by breathing the exhalations of chemicals from the pans, and not by any deleterious mineral in the ore.

[From a Lecture by LAURENCE TURNBULL, M.D.]

TESTS OF THE HEARING BY MEANS OF KOENIG'S RODS.

SAVART fixed the lowest limit of the human ear at eight complete vibrations a second, by means of a toothed wheel and an associated counter, and the highest limit at twenty-four thousand vibrations. Helmholtz has fixed the lowest limit at sixteen vibrations, and the highest at thirty-eight thousand. Vierodt gives the highest tone as forty-eight thousand, and Despretz as seventy-three thousand seven hundred single vibrations in the second. By means of a pendulum swinging a given distance and striking a steel Koenig rod, a definite degree of intensity is obtained. With this instrument a series of experiments were made by Dr. C. J. Blake, of Boston, Mass., to ascertain the average perceptive power in the normal ear, and this was found to vary considerably with the age; thus, at about the ages of twelve and thirteen years, a tone of forty thousand nine hundred and sixty vibrations per second was heard at a distance of thirty-four feet; at the ages of from eighteen to twenty years, the same tone was heard only at distances of from thirteen to sixteen feet; and at the extreme limit of thirty-four feet the tone of thirty-six thousand eight hundred and sixty-four only; at the ages of from twenty-eight to thirty years, at the extreme limit of thirty-four feet, only tones up to thirty-two thousand seven hundred and sixty-eight vibrations per second were perceptible; while above the age of fifty years the limit of perception at the same distance had still further diminished, and in a greater variety of degree.

In our experiments for the production of the musical tones, the steel rods of Dr. Koenig, of Paris, employed, were made of choice white-tempered steel, under the supervision of Dr. Clarence J. Blake. The rods are two centimeters in diameter, and from one inch to four in length, and from twenty thousand vibrations per second to sixty thousand. They are suspended by means of fine wire or string, or, better, fine but strong silk thread. Vibration is produced by a stroke from a steel hammer. In each experiment the rod is held at a uniform distance from the ear to be tested. Before commencing our experiments on any individual, we determined accurately the condition of his organ of hearing. Barometric pressure 30°, and temperature 65° Fahr. With this arrangement of the rods, the following were the results obtained by a series of experiments which were found to vary with the age and condition of the hearing apparatus of the individual:

Age.	Distance.	Number of Vibrations.
15	35 feet	40,000
18	"	40,000
21	"	35,000
25	"	30,000
30	"	25,000
50	"	25,000
60	"	20,000

In only one instance did a trained musical ear hear sixty thousand vibrations in a second. It will be seen by these and numerous other experiments which have been made, that the highest musical tone obtained in a normal, healthy ear, not specially trained, did not exceed, in any instance, a fraction over forty thousand vibrations in a second. Education of the ear and brain to the recognition of musical tones is as necessary as the training of the athlete to run, box, row, bat, or lift weights. Most wonderful instances of the power of the trained ear are found on record.

In every instance, when the individual experimented upon was fifty years of age, or over, there was found a change in the auditory, or sound-conducting apparatus, and even in the case of individuals who were from eighteen to thirty years old, it was rare to find both ears of the same power. In other instances, where there was no defect in the ear, there was found a want of musical perception (application).

A gentleman (Dr. J. Solis Cohen) who has given much study to sound, throat, vocal chords, etc., was desired by the writer to repeat his experiments with the rods, which he kindly complied with. On returning them, he stated that he could not hear a higher number than thirty-five thousand vibrations per second. I stated at once that there must be some defect, and expressed a wish to examine and test his hearing, never having done so before, and without knowing of any peculiarity in regard to his hearing. On examination, I discovered that in the right ear there was an opacity or thickening, on the inferior quadrant of the membrana tympani, and this was confirmed by testing his hearing by the watch (of thirty inches normal hearing), when I found his right ear was less acute in hearing by four inches. He then wrote for me the following note of his case, a copy of which I append:

"I have recognized for a long time, in delicate auscultations, that hearing in my left ear is little more acute than in my right, but I can hear the upper tones of the rod of thirty-five thousand vibrations, apparently as well with one ear as the other, the musical tone being distinct, though faint. In the rods of forty thousand vibrations and upward, I can distinguish nothing but the thud. For ordinary purposes I am not conscious of any difference in hearing capacity, nor aware that my hearing is less acute than that of the average normal subject."

This instrument of Koenig's is of value in diagnosis, as was shown in the above case, and in many others, and will determine with great accuracy any deviation from the standard of health which we have determined, according to the age of the individual. It can be mounted on a stand and struck with a hammer, as in the case of the tuning-fork, and will be found a useful addition to our mechanical means of diagnosis.

ON THE PERCEPTION OF THE HUMAN VOICE.

THE first impression we receive is that the more or less deaf patient is able to answer our questions in an ordinary tone of voice. If he can not hear us, or we have to elevate our voice to a loud tone, we at once make a diagnosis in our mind, and so register it; and if he speaks in a very low tone, we also draw certain evident conclusions from it, as to its nervous origin and his power of modulation. The consonants are the most difficult to hear by the diseased ear, the vowels being much more readily heard by the deaf patient, such as *a, e, i, o, u*. In cases of partial destruction of the membrane, the vowels were heard disproportionately better than the consonants, which were less distinctly heard in proportion to the size of the defect, and the better in proportion to the pitch of their ground-tone and the number of their harmonies; a rhythmical utterance diminished the difficulty.

On experimenting with an artificial meatus and membrane it was found that the resonance was much greater for the voice, and that partial destruction weakened and raised the pitch of the resonance, for the further reason that it possesses many sounds which are far weaker and more delicate than the tones of instruments.

The following experiments, to determine and confirm some of these points of hearing, were made on the healthy ear, in the open air, during the year 1874, at Russelton, Fauquier County, Va., under our directions, and with the assistance of three scientific friends. The situation was three and a half miles from Warrington, one thousand feet above the level of the sea. Temperature, 70° Fahr. Pressure of barometer, 30°. No excess of humidity. From the gate of an avenue of small trees, 233 yards distant, the vowels of the alphabet were heard in the following order: *a*, 233 yards, most distinct and clear; then *o*, 230 yards; *e*, 220 yards; *i*, 220 yards; *d*, 200 yards; *g*, 150 yards; these experiments being repeated in a closed hall with the same results.

At 40 yards (the greatest distance at which the human voice is heard distinctly) we heard every word, although certain vowels could be heard at 600 yards.

ELECTRICITY IN EAR DIAGNOSIS.

A DISEASED ear can not be considered fully examined and the means for its cure exhausted, until the galvanic current has been used in a scientific manner. It has been observed, both by ourselves and other careful observers, that a sensation of sound is perceived, even in the healthy ear, when one of the poles of a battery is placed in the auditory passage when filled with salt and water, and the other connected with different parts of the body.

Some recent writers are in doubt upon this subject, and state that this has not been proved to their satisfaction; and some recent experimenters attribute the subjective auditory phenomena observed by Brenner and others to stimulation of branches of the facial, and through this nerve to the action of the muscles of the middle ear, particularly the stapedius.

Dr. Poorten, in a review of the theory concerning the origin of the subjective symptoms consequent upon the application of the galvanic current, gives the results of experiments upon himself and others, and disproves the theory founded by Wreden, upon the supposed action of the current upon the stapedius and tensor-tympani muscles. The experiments consisted in the use of Siegle's pneumatic speculum (before referred to), by which the membrana tympani was drawn outward, and traction made upon the tensor-tympani and ossicles, or, on the contrary, relaxation. Under these circumstances, the galvanic current gave precisely the same reaction that it did before the use of Siegle's speculum. Dr. P. concludes that the action of the stapedius muscle by Wreden (namely, the production of intra-labyrinthine pressure by its contraction) is not only disproved, but is denied by later observers. That neither the facial nerve, the branch of that nerve passing to the stapedius muscle, nor the muscle itself, are directly acted upon by the galvanic current. Subjective symptoms were educed by the action of the galvanic current, when the contraction of the stapedius muscle was prevented.

We firmly believe that the auditory nerve can be excited by the galvanic current, if properly applied, and there is no resulting paralysis. We have performed numerous experiments upon our own ears, as well as other persons'. The mode of its impression, or the way that it is connected with that nerve, may be by the facial, for we know that there is in the internal auditory canal a few facicles of fibres, which constitute what Wresberg has termed the "portio-intermedialis," forming a connecting link between the auditory and the facial. Confirmation of the above has been given by means of the rods of Koenig.

Blake finds that the passage of the current increases not only the limit of perception of musical tones, but also the intensity of perception—the degree of increase in intensity of perception being a measure of the degree in which the auditory nerve responds to the stimulus. We believe that the galvanic current is a most valuable auxiliary in the treatment of diseases of the ear, and must not be omitted, especially in cases of a nervous character, after all symptoms of disease of the external and middle ear have disappeared or been removed. Of the mode of application, which is of importance, and the kind of electricity which is most useful, we are unable to enlarge at this time.—*Medical and Surgical Reporter.*

ALTERATIONS OF THE BRAIN IN TYPHOID AND TYPHUS FEVERS.

DR. LEO POPOFF, of St. Petersburgh, has lately examined, microscopically, the brains of twelve individuals who had died of typhoid fever, and in all he found changes of an acute inflammatory character, involving not only the walls of the blood-vessels, but also the neuroglia and the ganglion cells. There is proliferation of the elements which form the coats of the vessels, accompanied with a deposit of fat and pigment. The neuroglia is infiltrated with young cells, due to the repeated subdivision of its nuclei, and the ganglion cells are not only surrounded with wandering cells, which fill the so-called pericellular spaces, but are also penetrated by them. At the same time the nuclei of the ganglion cells undergo division, and the ganglia may become filled with smaller cells, which fall out in the course of microscopic preparation, leaving a number of perforations in the section. Wandering cells are found, not only round the ganglion cells, but also along the coarse of the vessels and the nerve-fibres, but they are most numerous close to the ganglia.

PRESERVATION OF THE DEAD.

THE Brunetti method, by which Mazzin's body was recently embalmed, consists of several distinct processes. First, the circulatory system is cleansed thoroughly, by washing with cold water till it issues quite clear from the body. This may occupy from two to five hours. Then alcohol is injected, so as to abstract as much water as possible. This takes about a quarter of an hour. Ether is then injected, to abstract the fatty matter. This occupies from two to ten hours. A strong solution of tannin is then injected. This occupies, for thorough imbibition, from two to ten hours. The body is then dried in a current of warm air, passed over heated chloride of calcium. This may occupy from two to five hours. The body is then perfectly preserved, and resists decay, and the Italians exhibit specimens which are as hard as stone, and retain perfectly every detail of form and feature.

THE EAR.

IT has been experimentally determined that vibrations of the membrana tympani are communicated, through the chain of auditory ossicles, to the membrane closing the fenestra ovalis; while the movements of the latter are transmitted by the liquid contents of the labyrinth to the membrane closing the fenestra rotunda. But the faculty of hearing is not wholly lost even when the stapes is rigidly ankylosed to the bony margin of the fenestra ovalis; when the auditory vibrations, therefore, can not follow their usual path along the ossicles. Politzer has endeavored to get over this difficulty by supposing that the sound-waves, in such cases, reach the labyrinth through the bones of the head. The alternative view is that the vibrations of the membrana tympani are transmitted to the membrane closing the fenestra rotunda through the air contained in the tympanic cavity. The question has recently been investigated by Weber-Liel. His experiments were made on petrous bones freshly taken from the human subject and the horse. After dislocation of the ossicles and closure of the tympanic chamber, sound-waves generated in an organ-pipe were admitted into the external meatus; the tympanic membrane was thrown into vibration, and consentaneous movements of the membrane closing the fenestra rotunda were seen to occur. When the sound-waves were allowed to impinge upon the surface of the temporal bone instead of entering the meatus, no vibration of this membrane took place. Hence the author concludes that Politzer's view is untenable, and that the air in the tympanic chamber is capable of serving as a partial substitute for the chain of ossicles, by transmitting sound-waves to the labyrinth through the fenestra rotunda.

MESSRS. HOOPES & TOWNSEND, of Philadelphia, have introduced improvements in their machinery for punching cold iron, by which they are able to punch a half-inch hole through an inch and three quarters thickness of wrought-iron cold, making a perfectly smooth perforation.

[Zoologist.]

NATURAL HISTORY.

ARCTIC FOX.

THE Arctic fox is a very interesting species of this genus. It is either (and that irrespective of the time of year) bluish white or gray. Its coat, which is wonderfully soft, forms an article of commerce with the Hudson's Bay Company. It is considerably smaller in bulk than the polar hare, which, when grown up, generally weighs about eight pounds and three quarters. Its flesh is no delicacy. Barentz, and since him several other Arctic travellers, however, found it enjoyable, and we (Pansch and Copeland) did our best to eat it. The Arctic fox has, with but few exceptions, none of the cunning attributed to our own Reynard. At least our recollections of it (except in one or two cases) are of a most harmless character. During the winter we succeeded in catching some after the manner of the Esquimaux. Once one was taken out of the trap, and laid down for dead, but after a time it sprung up and rushed away. For the young ducks, for which it has a great weakness, the fox is a bitter enemy. It lives upon any thing it can get in winter, even shell-fish and other salt-water produce which is brought by the tide on to the strand-ice. In the summer, lemmings seem to be its chief food. Nearly the whole of the winter and spring we kept some prisoners in the engine-rooms; in such close proximity to the coals they all turned black. Two of them died of tubercles on the lungs. A beautiful gray fox had to be garroted in the cabin for refractoriness; another was set free, and the last deserted the cage that we had made it and put upon the ice near the ship: this desertion, which was brought about by the melting and falling down of the block of ice on which the cage stood, and which we all witnessed from the deck, had something particularly comical about it. The fox, which had almost waned away to a skeleton, began to stretch himself, then to stick out his bushy tail like a broom, wriggled his lanky body into a pool of water, and lastly, as elegantly as a dancing master, and as if longing for liberty, started off without deigning to cast another look at the ship.

The European fox shuns mankind, but the Greenland fox seeks man's society, in perfect innocence and without any suspicion, for it hopes to profit by him. It is the first, after a fortunate day's hunting, to show its astonishment and also hasten to enjoy the spoil, as well as steal a reindeer ham from the sledge in the night and carry it away. It accompanies him on hunting and sledge journeys at a respectful distance, and employs his time of rest in visiting, opening, and plundering the sack of provisions. An ice-bound ship it watches with great favor, for there is always some lucky chance bringing him some opportunity of profit, and things which can be easily carried away. Indeed, it is so accustomed to sponging upon others that it is often difficult to make him ashamed of himself. If, after hours of constant gnawing, or, when in company with others, his envious snarling, one goes out of the tent to stop his tugging at the ropes, instead of going away humbly, he looks boldly into his benefactor's face, barks at the firing, and goes off reluctantly. At other times they come curiously trotting along, not allowing themselves to be frightened by the firing, and a piece of bacon-rind will entice them to follow the sledge for miles. It is a troublesome piece of work to skin a fox newly killed, in the icy cold; its warm skin forming a warmer neck-tie on that account.

REINDEER AND MUSK-OX.

The Greenland reindeer differs at least from the American, Laplandish, and Spitzbergen species. Its horns are not shovelled at the tips like theirs; they are also more upright. It carries its head and neck high; its whole build is elegant, and reminds one, in every respect, of the European deer. Kane and Hayes also met with them in the most northerly parts of West Greenland. Our excursions taught us that they increase in numbers towards the interior of the country; indeed, at the back of Kaiser Franz-Joseph Fjord, in the neighborhood of a glacier remarkable for its luxuriant vegetation, we came upon a tolerably good footpath trodden by the reindeer.

The musk, or, properly speaking, the sheep-ox is somewhat smaller than the European ox. Its threatening is quite in contrast to its harmless nature; its color is black; its hair long, and falling in rough masses, though on its back is some wool, not to be surpassed in fineness. Payer pulled out the wool of three that were killed, on Kuhn Island, to wrap a number of fossils in, for transportation, and took a careful sketch of one of the most stately. Its eyes are particularly small. As the name implies, the creature is distinguished, according to its age, some more, some less, by the smell of musk in its flesh and fat, to which, however, one can accustom one's self as to the smell of train-oil. Its flesh, upon the whole, greatly resembles that of our own ox. The first we saw and killed was on Shannon Island, in August, 1869. As we did not then know this animal we made the strangest guesses, comparing it to a gnu. Like the reindeer, it lives on vegetable food, which is scanty enough here. Scarcely anywhere in Greenland does the flora suffice to change the face of the soil; at the utmost it only serves to shade it. Moss, lichen, grayish-green grasses, ranunculus, saxifrage, etc., form meagre solitary patches among the weather-beaten stone heaps. Here and there the plains are covered with birch-bushes, a few inches high (the stems of which are often no thicker than a lucifer-match), also with bilberry-bushes, but more often with sallows creeping along the ground. Almost every species of the flora of the plain, especially the garden poppy, did we find on mountains from 1,625 to 3,250 feet high. On the summit of a rock 7,495 feet high grew—near the well-known black and yellow lichen, known everywhere in the European Alps as the last representative of vegetation—a long fibrous kind of moss. The greater summer warmth of the rocky interior of the country insures there a more varied flora. Former Esquimaux settlements, if only covering a few square fathoms, were at once recognizable from their light-green color, caused by constant manuring. Meadows, in our sense of the term, were nowhere to be seen.

How far north the musk-ox and the reindeer are found we can scarcely decide; the first we met with in 77° N. lat., and the last only in 75°. The scanty means of existence afforded by the soil compel them to constant wanderings. Both animals are almost always met with in herds, sometimes of from twenty to thirty head. The greatest number of reindeer we ever saw were between one hundred and two hundred head, on a hilly ground to the west of Cape Broer Ruys; and the greatest number of musk-oxen in the brown-coal district of Kuhn Island. To the former we gave battle. Their behavior towards the hunter is in no way similar: the reindeer approaches him at a brisk trot, full of curiosity, to within a few steps—indeed, sometimes they come quite close to him; the musk-ox remains, as if rooted to the spot, staring at the strange, unknown enemy, and arrives very slowly at a resolution. At Cape Philip-Broke four of them most humbly condescended to play with Payer by pretending to carry off his portable table. Older animals stand fire most coolly, even after being wounded, and defend the most exposed part by putting down their heads, which is their invulnerable part. One of them once received a shot from a Wanzl-gun on his mailed forehead without showing the slightest annoyance—the ball fell a flattened disk on to the ground. If a family or herd of young ones are surprised, they either form a square (the young being in the centre, and the old outside with their heads down), or else the bull, placed as a sentinel, takes to flight, and the others follow closely, the placing of their outposts being astonishing. They are also excellent climbers; a retreating herd climbed a snow-path at an incline of not less than 45° on a high mountain near our winter harbor, and to our great astonishment we saw one looking down upon us from between the craggy walls of Cape Hamburg. At the first shot a herd of approaching reindeer will make a spring and then stand terrified; the next shot, or the fall of one of them, puts the rest to flight. It costs something thus to dispel their innocent confidence. Once a reindeer ran hurriedly over the land to a boat that was landing: it stood close to us on shore, with its head stretched out and its large soft eyes watching us confidingly. One of us sprang hastily on shore, and it ran off. On another occasion a number of them came close to the tent. But a scene took place, which many of our hunting friends would envy us, in a herd near Cape Bennet, in August, 1870. We had just left our boat, which we were going to load with seven carcasses which we had killed some days before and left behind; but unfortunately they had all turned bad, as we had neglected to open them. Suddenly there came from twenty to thirty head over the mountain slope, and upon reaching a snow-field all lay down enticed by the refreshing coolness and our own example, as we had just done the same thing. As, however, we started to continue our journey, the front guard of the reindeer rose to do the same; but it happened that one of them—evidently the leader—seemed displeased that the greater number took no notice of the movement, as they desired to have a little more rest, so it stopped the others, turned back, and went to each animal separately, pushing it with its horns, until they all stood up and began their march together to a new grazing place. The flesh of the reindeer is good, though somewhat soft and spongy. It is plain that these creatures were very useful to us, and that without them we should often have been in a sad predicament. Unfortunately our furthest and most productive hunt took place shortly before we left Greenland, and over against the island of Jan Mayen. We had to throw more than a thousand pounds of reindeer and musk-oxen flesh overboard, as the rising of the temperature beyond the pack-ice, together with the damp, turned it all bad.

WALRUS.

If any creature deserves the name of monster it is the walrus. It is from nine feet six inches to sixteen feet six inches long, weighs about 20 cwt., and its skin is three inches and a half thick (a sort of massive coat-of-mail), with a head of infinite ugliness, rather large eyes, and tusks sometimes thirty inches long (of a sort of ivory), which helps the creature to obtain his food (chiefly mussels) from the bottom of the sea, and, together with the breast-fins, help him to climb on to the floating ice to a place of rest. Round his jaws are long cat-like bristles, as thick as a large darning-needle. Demoniacal as his appearance is, his voice is as bad—a jerking, imitative scream, lowing and puffing, often repeated, and in which it seems to delight. Walruses and seals, from their richness in train-oil, are highly estimated in the Arctic fishery, and are invaluable to the Esquimaux; indeed, in many cases when—either from the blocking up of the coast with ice, or the retreating of the herd—they have been unable to catch any, they have almost died of hunger. One way the Esquimaux have of killing the seals is to approach them by degrees with a white screen, behind which they crouch; and another by lying in ambush amongst the ice and harpooning them. One of the largest walruses that we saw was killed on the ice near Shannon, on the 27th of August, 1869, by Dr. Copeland: it measured nine feet eleven inches in length. The skin is particularly flexible and soft, and the leather we used for straps for the machinery. The time it remains under water depends upon the time the creature has had for preparation. If a walrus is suddenly hunted from his sleep into the water it must rise again immediately to the surface. Now it takes a deep breath. If it is again hunted it comes up again; if this is repeated five or six times the walrus then seems to be provided with a store, for now it dives in reality, and is seldom seen again.

Walrus-hunting is very dangerous, for in its fury this animal can break through ice six inches thick. If, therefore, it is not met with on strong old ice, it is necessary to change one's place very quickly, for (as is the case with all mammals) the walrus is obliged to come to the surface of cracks, or iceholes, kept open for the purpose, in order to breathe every ten minutes. The animals notice exactly the direction and the distance of their enemy, and emerge at the spot to meet and destroy him. Returning from the sledge journey from the Tiroler Fjord, we had abundant opportunity of proving this. Contrasted with its ferocity in the water, there is nothing more innocent and harmless than a herd of walruses sunning themselves on an ice-floe or the shore, or indeed sleeping on the water; but unfortunately the comparison with a torpedo (which, for fear of some accident, one dares not touch) is only too well founded. A single ice-floe often bears twenty and sometimes a much larger number of these creatures, their dark, sphinx-like bodies lying close together, the head, from their long tusks, leaning sideways or upon one another; and thus they sleep away the greater part of their existence in the sun, lulled by the rushing and roaring of the breakers. The walrus surprised on shore or on an ice-field is utterly helpless, and, although it strikes furiously on all sides with its tusks, is just as harmless as it is terrible when its anger is aroused in the water. One peculiarity, which under some circumstances may be very dangerous, is its great curiosity. Should one of these monsters see a boat, it rears itself, astonished, above the surface, utters at once a cry of alarm, swimming towards it as quickly as possible. This call brings up others, awakens the sleepers, which the boat had carefully avoided, and in a short time the small vessel is followed by a number of these monsters, blustering in apparent or real fury in all their hideousness. The creatures may possibly be only actuated by curiosity, but their manner of showing it is unfortunately so ill-chosen that one feels obliged to act on the defensive. The bellowing, jerking, and diving herd is now but a short distance from the boat. The first shot strikes, and this inflames their wrath; and now begins a wild fight, in which some of the black sphinxes are struck with axes on the flappers, with which they threaten to overturn the boat. Others of the men defend themselves with a spear or with the blade of an oar. Often, from some unknown cause, these creatures turn suddenly from the fight, jerking and diving under water, and when at some distance turn their ugly heads to look back and fill the air with their vindictive grunts. In the summer of 1869 a boat excursion to Cape Wynn with difficulty escaped the destruction of their craft. Another time they were followed by a herd, and succeeded in reaching the shore of an island, where, though only for a short time, they were blockaded in. The longer you live in Arctic regions, the less can you persuade yourself to attack these creatures in their own element, unless forced by pressing circumstances—*i.e.* want of either food or of oil—and then it is advisable, if in boats, to provide one's self with cartridges. The most successful hunt is when these creatures are surprised on the ice-floes. When approaching very near them the oars are shipped and the boat noiselessly landed. The hunters get upon the floe behind the creatures; but scarcely does one raise its head in contempt and anger than all the others wake up, and the whole herd press forward, pushing the young ones with them to the edge of the floe, where they tumble headforemost into the water. Only this short time is at the hunter's disposal, and his shots must be quick and true. Should one of the young ones be killed, the mother carries it with her flappers, challenging her enemies to fight, with a fierce look. A walrus once killed is quickly made fast with a rope to the boat before it sinks. The weight of these creatures is so enormous that two of them which we had hoisted on to the same side of the deck gave it a decided inclination. We were obliged to eat seals as well as walrus, and that, too (more often than not), raw; their flesh has a strong flavor of train-oil; that of the latter is almost black, the liver a beautiful violet. Both creatures have the extraordinary habit of occasionally swallowing stones.

SEAL.

The seal is from three to six feet long, perfectly harmless and defenceless. It is cautious and suspicious, and will dive for the slightest cause. Indeed, its apish face, with its peculiar expression of curiosity, is in and out of the water every minute. Seals live in herds: seal-hunters often find hundreds on one ice-floe. Whilst they sleep or sun themselves they set a watch, which being killed the whole herd may often be taken. A seal-hunt is carried on in different ways: the most successful is with clubs. Their skull is very weak. Our bullets had the effect of blowing them to pieces. The most fruitful ground for seal-hunting is the neighborhood of Newfoundland and the lonely island of Jan Mayen, lying within the Arctic Circle. In southern latitudes they rarely appear. When dead they sink very quickly. To the Esquimaux the seal and walrus are of universal utility: they cut strips out of their skin, make dresses, finish their boats, cover the floors and walls of their snow huts: their bones they use for the repair of their sledges and weapons; their fat as fuel, their flesh for food: in a word, wherever Esquimaux exist, seal and walrus are eaten.

GREENLAND HARE.

The European hare is remarkable for its long and rapid hasty flight and its timidity; the Greenland hare, on the contrary, sits as if nailed down in its rocky refuge, however near the hunter may pass to him. Sometimes one sees the mountain slopes dotted with white spots, which, from their motionlessness, might be taken for snow; but they are only white hares. They are about the size of our own hares; but their flesh, like that of the Alpine hare, is insipid. Hare-hunting in Greenland often gives rise to the drollest scenes. Their hearing appears to be even weaker than their sight. Payer once stood near a hare which was startled by repeated firing, but had confined its flight to a few steps: the creature was nibbling the moss quietly. Payer took out his sketch-book, and drew it in all the different positions which, in its uneasiness at the conversation and laughter of his companions, it assumed.

WOLF AND WOLF-LIKE DOG.

The peculiar species of wolf met with in other Arctic neighborhoods is not found in East Greenland, neither is the wolf-like dog, now dying out from disease, and upon which the existence of the Esquimaux in East Greenland is completely dependent. Brown, in his "Fauna of Greenland," believes that the dogs brought by Torell from Greenland to Spitzbergen in 1861, to work the sledges (a plan frustrated by the sea being found open), would increase rapidly and return to the original wolf type. They are also unknown in the north of Europe, and, like the ice-bear, fox and reindeer, are peculiar to the Arctic Circle.

ARCTIC BIRDS.

Interesting, too, is the more or less periodical return of a large number of birds which animate the Arctic world, some for only the summer weeks, and some for the whole year, such as ptarmigan and ravens (both of which remain through the winter); a number of screaming birds—most of which are species of gulls distinguished by their greediness—such as the auks, the divers, and, above all, the eider ducks. These cling like so many white spots to the clefted rock, screaming to each other or sitting in a circle on the edge of a floe. A short early ice-covering of the coast water, indicating the close of a fleeting summer, has many embarrassments for them; and soon the far greater part accept the signal for emigration to southern regions. The west coast of Greenland is much richer in birds than the east coast. Our share was therefore proportionately small. The flesh of Arctic birds has, doubtless owing to the nature of their food, a strong taste of train-oil.

INDIGO.

PLANTS which produce this coloring matter are plunged in vats till the water has deprived them of it to a great extent, and the liquid is then evaporated to obtain the indigo. A pretty high temperature is necessary during this steeping; but hitherto no use has been made of artificial heat, as it has been thought that the temperature of the surrounding air, which is generally high in the countries where this industry is carried on, is sufficient for the purpose.

M. Olpherts has tried the use of steam, and the results of his experiments in India, with rather rude apparatus, appear to warrant the change. The temperature of the water in the rainy season varies from 92° to 95° Fahr. In the vats it has been raised to 111°, and, in spite of the difficulties attending the new process, an increase of produce has been obtained of about 25 per cent in comparison with plants of the same crop, steeped in the same vats, the same day, and for the same length of time.

Heat has also been applied during the beating, and good results have been obtained without injuring the color or quantities of the indigo. Moreover a fresh steeping for forty hours of plants treated with artificial heat gave no indigo, while those subjected to the ordinary process still retained some.—*Technologiste.*

[Engineering.]

DUBOIS AND FRANCOIS' ROCK BORING MACHINERY AT THE ST. GOTHARD TUNNEL.

WE illustrate bleow the rock-boring machines of MM. Dubois and François, which, amongst many other types, are being employed at the works of the St. Gothard Tunnel. The following are its principal dimensions :

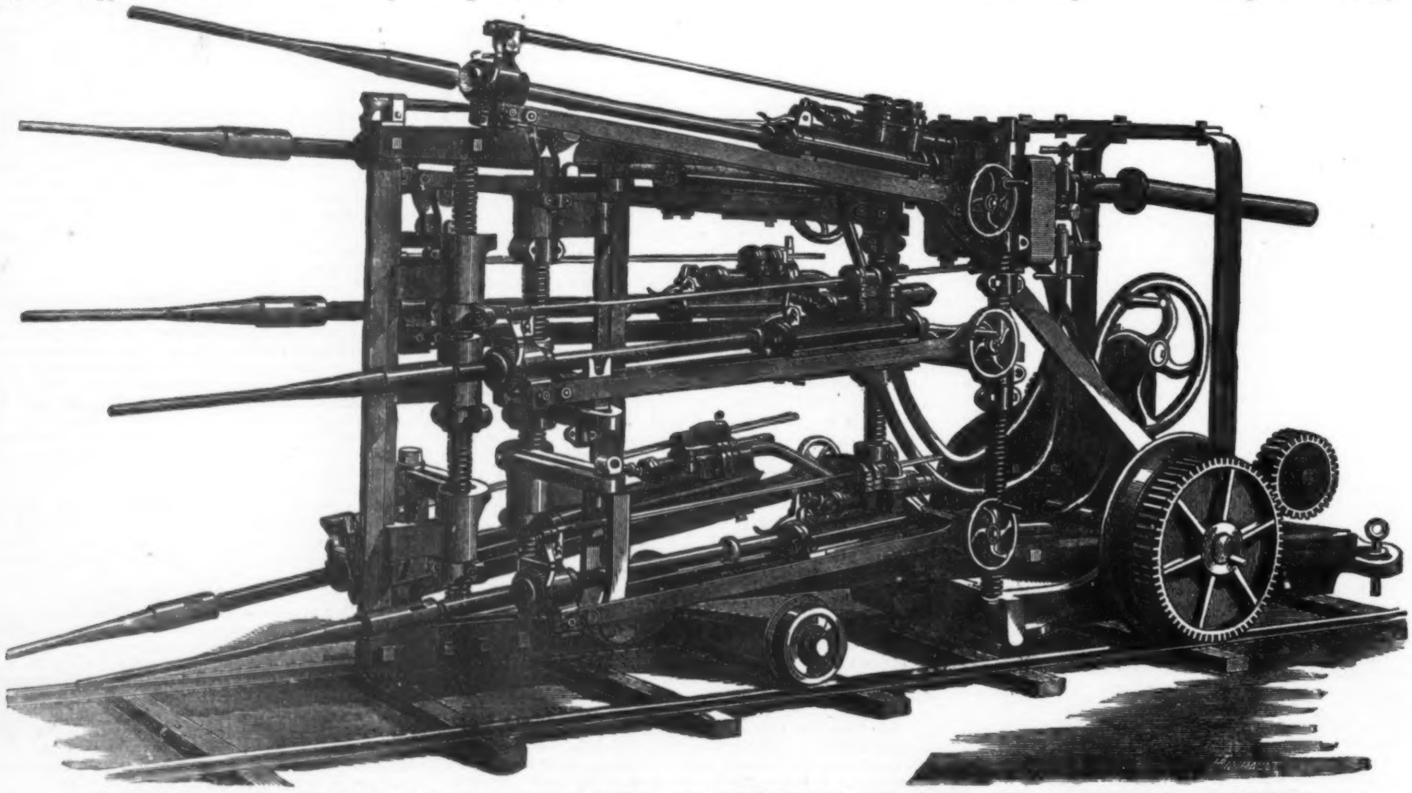
Diameter of cylinders	2.75	in.
" " striking piston-rod	1.97	"
Total length of the apparatus	86.61	"
Total width of the apparatus	9 0	"
Total weight	484	lb.
Weight of striking piston-rod, without drill.	61	"

Each drill consists of four parts : a gun-metal cylinder, a distribution valve, a piston carrying the drill holders, and a frame formed of two bearers. The compressed air employed to work the drill enters the cylinder A, Fig. 1, by the orifice O, Fig. 2, closed at the ends by the pistons B C, which are connected together by the frame carrying the valve D. The diameter of the piston C being greater than that of B, the air pressure forces the whole of this combination towards the right, the port *l* is opened, and the compressed air enters the cylinder E, and drives the piston and drill attached to it against the face of the rock. But during the operation the compressed air in the chamber A passes by the ports *i i* behind the piston C, and reverses the motion ; the combination B C D is then moved to the left ; the port *l'* is opened and the air pressure is exerted behind the piston F, whilst the air which was previously used to drive the piston forward, escapes into the atmosphere through the opening *l*. The piston then returns, but before arriving at the end of its stroke, and by means of a swelling G on the piston rod, the finger H is lifted, and consequently the valve I is opened. The compressed air behind the piston C then escapes into the atmosphere, and the apparatus is thus in a condition to repeat the operation first described of delivering a second blow upon the face of the rock. By this arrangement it will be seen that while the compressed air acts instantaneously on the piston in making a stroke, it acts only progressively in returning ; it will also be seen that by changing the diameter of the small opening *i*, the speed of the machine will be modified.

The rotation of the drill is effected by means of the two pistons P and P', Fig. 3, which are subjected alternately to the compressed air by the opening *m*, and transmit their motion to the ratchet R by means of the lever K, the rod T, and the pawl N, Fig. 4. The forward motion of the cylinder, as the depth of the hole in the rock increases, is effected by turning the handle M and the screw V, Fig. 2. This method of moving the drill forward is found preferable, as the speed can be regulated at will, according to the nature of material to be attacked.

The drills are mounted in groups on a frame placed upon wheels, and running upon the temporary rails laid up to the face of the heading. The groups are larger or smaller according to the nature of the work. Generally, the heading is about 6 ft. 6 in. square, and four drills can be easily worked, mounted as shown in the perspective view on the opposite page. At the St. Gothard works, however, six drills are carried in the frame, the construction of which is shown clearly in Figs. 5 and 6 ; whilst Figs. 7 and 8 show a hanging guide, which supports the end of the drill, and is carried on a rod, keyed to the rod T, showed in Fig. 1. Fig. 9 shows various kinds of drills employed.

At the St. Gothard Tunnel, the results obtained with this drill are extremely good, and a daily mean advance of 11 ft. 10 in. has been made with it. We may mention that we are indebted to our contemporary, *La Nouvelle Portefeuille des Machines*, for the foregoing particulars, and our illustrations have also been copied from that journal.



DUBOIS AND FRANCOIS' ROCK-BORING MACHINERY AT THE ST. GOTHARD TUNNEL.

THE American Needle and Fish-Hook Company, New-Haven, Conn., employ in all departments about thirty hands, and have a capacity for turning out from 10,000 to 50,000 fish-hooks per day on each of their ten machines, the machines being made expressly for the business. This is the only concern in the world that makes hooks by machinery. The large machines turn out from 25,000 to 30,000 hooks per day, while 1500 is a good day's work for a single man in the old way.

[From the Proceedings of the Institution of Civil Engineers, London, 1875.]

THE ST. GOTHARD TUNNEL.

By D. K. CLARK, M. Inst. C. E., London.

[Continued from page 167.]

ROCK-BORING MACHINERY.

THE machinery for boring the rock in the tunnel consisted of two distinct parts—the perforators, or rock-drills, and the air-compressing machines, for supplying compressed air to work the perforators.

AIR-COMPRESSING MACHINERY.

Temporary machines, constructed by the Cockerill Company, Seraing, were at first erected, capable of supplying 77 cubic feet of compressed air per minute ; this quantity was sufficient to work twelve perforators. At each end of the tunnel, a pair of horizontal direct-acting steam-pumps were laid down. The steam-cylinders were 19.7 inches in diameter, and those of the air-pumps, 17.73 inches, with a stroke common to both, of 3.64 feet. The flywheel was 16 feet 9 inches in diameter, and its weight was 6¼ tons. The air-pumps worked in water similar to Sommeiller's pumps at the Mont Cenis Tunnel. The minimum speed was five revolutions per minute, cutting off steam at half stroke ; but the machine could make twenty turns, equivalent to a speed of piston of 158 feet per minute. The compressed air was delivered into a reservoir 5 feet in diameter and 29 feet long. The volume of air compressed per stroke of the piston was 1.52 cubic foot, under a pressure of 3 atmospheres ; and, at a speed of twelve and a half turns per minute, 77 cubic feet of compressed air had been supplied per minute. The work done for one stroke of the pump, measured from indicator diagrams, was,

	Foot-lbs.
For the steam-cylinder	32,790
" air-pump	27,550

The work done in the air-pump was thus 84 per cent of the indicator power.

The temporary air-compressors were kept regularly at work until November 1873, when they were placed in reserve, and one of the permanent compressors was substituted.

PERMANENT PRIME-MOVERS AND AIR-COMPRESSORS.

The power is derived from water, through the agency of turbines. At the south end, the supply of water was found to be scarce—sometimes as low as 67 gallons per second—and it became necessary to work under a fall of nearly 600 feet, which was reduced by losses to 531 feet at the turbines. At the north end, the minimum supply is from 570 to 444 gallons per second with a fall of 385 feet. The power at each end was at first received by three turbines, each turbine driving a group of three air-compressors : in all nine compressors at each end. Two more turbines and groups of compressors were laid down at each end of the tunnel towards the end of 1874 to make up a full supply of air for the number of perforators then at work.

SOUTH END.

The turbines at the south end were constructed by Messrs. Escher, Wyss, and Co., of Zurich. They are horizontal, on vertical shafts. The crown is of bronze, cast in one piece with one hundred blades. The exterior diameter is 3.94 feet, and the total thickness is about 11 inches. At full power, the wheel makes three hundred and ninety turns per minute ; when the circumferential velocity is 80 feet per second. The distributor and the directing vanes are of bronze. On the upper end of the shaft of each turbine, a bevel pinion is fixed, and it gears into a large bevel wheel fixed on a horizontal shaft formed with three throws or cranks to work the compressors of one group. The turbines are ranged in line, and the horizontal shafts, pertaining each to one turbine respectively, are coupled together end to end, and so united into one continuous shaft. The work done by the several turbines is thus distributed equally over all the groups of compressors.

The three compressors of each group are connected at equal angles round the shaft, and are fixed on one base-plate. The cylinders or pumps are 18.1 inches in diameter ; the stroke is limited to 17¾ inches, in order that the mean speed of piston may not exceed 266 feet or ninety revolutions per minute, when the turbine makes three hundred and ninety turns. The compressed air is cooled on Dr. Colladon's system : every piece that is in contact with the air when undergoing compression is cooled by currents of cold water passed through air-tight envelopes ; the piston-rod is tubular, and is filled with cold water, which is circulated within it, and is at the same time extended to the interior of the piston. Water is also injected into the cylinder in fine spray ; and for this purpose it is doubly filtered, so as completely to separate the fine granite sand brought down by the Alpine torrents.

The clearance at each end of the air-pump does not exceed ¼ inch ; yet there is no liability to shock or concussion within the machine. The ingress and egress valves are inserted in the covers at the ends of the cylinder, and are closed by the action of helical springs. The area of opening of the ingress valves is .1 that of the piston, and of the egress valve .05. The egress valves are placed low, so as to permit of the simultaneous ejectment of the compressed air and the injected water at each stroke. The quantity of injected water on this system is less than .001 part of the volume of the air drawn in ; and it is not more than one fourth of the water which had been requisite in working the water-piston of the temporary pump.

The density of atmospheric air at such high levels is much less than at the sea-level. By the barometer it is only 87 per cent.

The compressed air from the pumps is discharged into four reservoirs, each 5.3 feet in diameter, connected successively with each other by pipes. Into the first of these the air and water from the pumps are delivered ; there the water is separated, and the air passes into the next reservoir, and so on successively. The succession of reservoirs serves to break the waves of pressure from the compressors. The capacity of each reservoir is about 600 cubic feet. The effective pressure is 7 atmospheres.

NORTH END.

The Girard turbine is employed at Goeschenen ; the turbines were constructed by B. Roy and Co., Vevey, who considered that the Girard turbine was capable of utilizing, with the best effect, variable quantities of water. With 279 feet of fall, and a maximum charge of water of 67 gallons per second, an effective power of 250 H. P. could be realized. The performance, when needed, may be raised to 280 H. P., in case it may be occasionally required to elevate the pressure to 10 atmospheres. The turbines are 7 feet 10½ inches in diameter ; they have eighty buckets, and their regular speed is one hundred and sixty turns per minute.

The production required for each group of compressors was 4 cubic metres, or 141 cubic feet, of compressed air, at an effective pressure of 7 atmospheres. For this rate of delivery, the compressor-shaft was timed to eighty turns per minute ; the diameter of the cylinders was fixed at 16.5 inches, with a stroke of 25.6 inches. For three compressors of one group the quantity of air drawn in would be 1.483 cubic feet per minute.

The piston of each compressor and its rod are hollow, and they are cooled by cold water circulated within them, on Colladon's principle. Cold water is also admitted through the periphery of the piston, which is 7 inches deep, and recessed in the middle to hold a stratum of the fluid. The fluid under a pressure greater than that of the compressed air, laps the interior surface of the cylinder, and effectually cools it. A portion of the water passes by the piston into the cylinder and cools the air.

The air is drawn into the compression-cylinders through two inlet valves in the upper part of each cover, and is discharged, together with the water collected in the cylinder, through three other valves, of less diameter, placed in the lower part of each cover, into a small receiver at one end of the cylinder. A float in the receiver, in connection with a cock, forms a self-acting arrangement for letting off a portion of the water collected in the receiver from time to time, thus preventing the water from rising to an inconvenient level. The compressed air is conducted from the upper part of the receiver into large reservoirs.

TOTAL QUANTITY OF AIR PROVIDED FOR, TO BE DELIVERED IN THE COURSE OF TWENTY-FOUR HOURS.

	At Atmospheric Pressure. Cubic feet.	At Eight Atmospheres. Cubic feet.
At the south end.........	4,941,000	917,625
At the north end.........	6,349,000	793,625
	11,290,000	1,411,250

PERFORATORS OR ROCK-DRILLS.

Dubois and François' perforator, the first machine employed in the excavation of the tunnel, is based on the principle of Sommeiller's perforator, used at the Mont Cenis Tunnel, but it is simpler in construction. There are four motions in the machine: 1st, the delivery of the blow; 2d, the turning of the jumper on its axis after each blow; 3d, the advancement of the drill to follow up the work; 4th, the withdrawal of the machine when the tool or the machine itself is to be changed, or when the hole is completed.

The diameter of the percussion-cylinder is 2.76 inches, and of its piston-rod 2 inches; the length of stroke varies from $\frac{3}{8}$ inch to 7.2 inches. The weight of the percussion piston, with its rod, is 62 lbs.; the total weight of the machine is $4\frac{1}{2}$ cwt. The length, width, and height of the machine are 7.2 feet by 9.2 inches by 12.6 inches. The boring bars which are keyed to the piston-rod of the perforator are of steel, octagonal in section, and 1 inch in diameter over the angles. In hard rock they work well at a length of 4 feet; in soils of medium hardness a length of 5 feet is suitable; and in easy rocks a length of from 6 to $6\frac{1}{2}$ feet. The capacity of the cylinder is 79.3 cubic inches, and the quantity of compressed air consumed per stroke is 97.6 cubic inches.

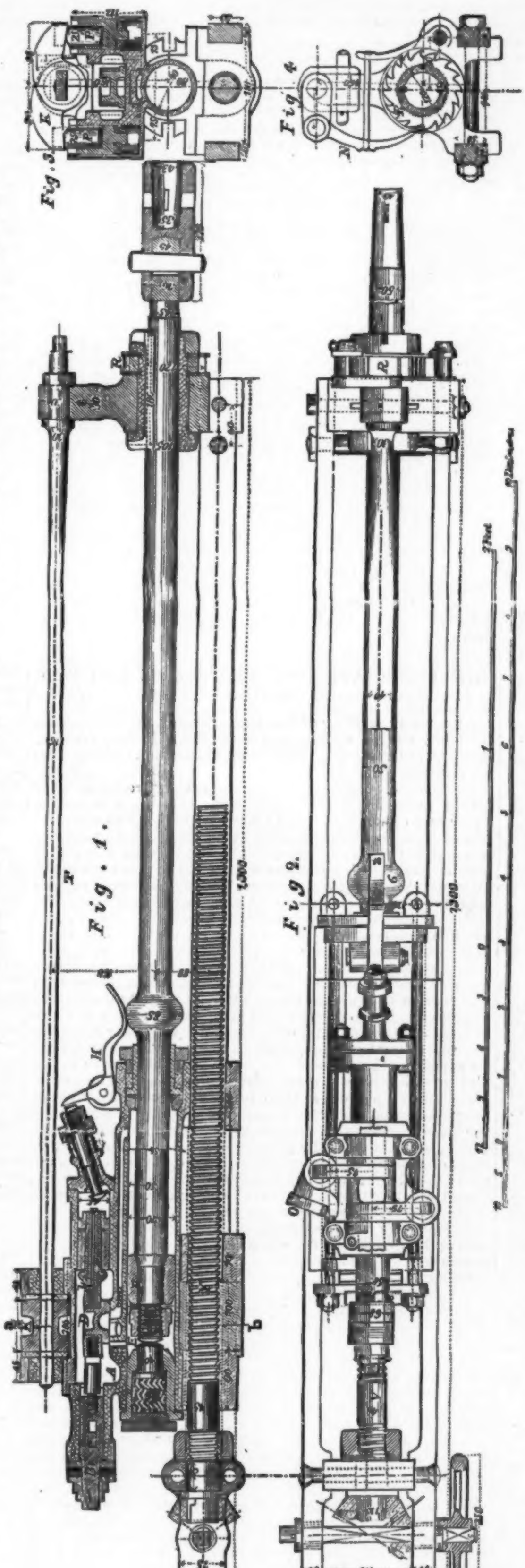
Ferroux's perforator, which, for the most part, superseded Dubois and François', by reason of its superior performance, contains an automatic movement by which the percussion-cylinder is advanced spontaneously, and keeps pace with the progress of the hole. In Dubois' machine, the advance was conducted by hand, and, for want of exactness in manipulation, frequent damage was occasioned to the cylinder by knocks and wrenches—a species of accident which has seldom happened to Ferroux's machine.

The automatic movement in Ferroux's machine consists of an air-cylinder fixed behind and on the centre line of the percussion-cylinder, having a piston and rod connected to the head of the percussion-cylinder. The piston of this, the propelling cylinder, is constantly under the pressure of compressed air, by the agency of which the percussion-cylinder is moved forward when freed to be moved, and is kept taut to its bearings in front when at rest. These bearings consist of a pair of ratchets, the forks of which are engaged in the teeth of two racks, one on each side of the machine. The teeth of these racks are placed at 1.2 inch pitch, and they measure the successive steps of the advance of the percussion-cylinder. When it becomes necessary to advance this cylinder a step, the ratchets are raised clear of the racks, and the cylinder is instantly moved forward by the force of the air on the piston of the propelling cylinder behind it. The ratchets fall into the next notches of the racks, and are there set fast by the propelling pressure, until they are again lifted for the next advance. The raising of the ratchets at the right time is effected by a collar on the percussion piston-rod, which strikes a tappet in connection with them, and raises them just as the stroke of the drill reaches its appointed maximum length. The percussion-cylinder is secured behind by another pair of ratchets, which engage in two other racks on the frame, the teeth of which turn the opposite way. The ratchets are set fast in the racks by the pressure of compressed air. By these means the percussion-cylinder is maintained perfectly steady whilst in action.

The slide-valve for distributing the air to the percussion-cylinder is moved by an eccentric on a longitudinal traversing shaft which passes over the whole length of the machine. This shaft is turned by means of a short vertical cylinder at the head of the machine, 3.6 inches in diameter, with a stroke of 2.8 inches. The speed at which this shaft revolves regulates the rapidity of the drill. At the same time, the independence of the movements of the valve with respect to those of the drill-piston gives rise to frequent false strokes, which cause a waste of air.

At the extreme end of the machine this shaft carries an eccentric, which, by means of a ratchet, gives to a wheel on the percussion-rod a definite portion of a turn for each stroke, and thus the revolving movement of the drill is effected.

The percussion-cylinder and its appendages can be instantly withdrawn from the front, by the pressure of the compressed air being reversed on the propelling piston. The diameter of the percussion-cylinder is 3.36 inches, and of its piston-rod 2.8; the maximum length of the stroke is 6.4 inches. The diameter of the propelling cylinder is 3.2 inches, and of its piston-rod 2 inches. The total weight of the machine is 4.91 cwt. The length, width, and height of the machine are 10.8 feet by 10.4 inches by 14.4 inches. The capacity of the percussion-cylinder is 104 cubic inches, and the quantity of compressed air consumed per stroke is 140 cubic inches. When regularly at work, the machine makes from two hundred and fifty to three hundred strokes per minute.



COMPARATIVE PERFORMANCE OF MECHANICAL PERFORATORS AT THE ST. GOTHARD TUNNEL.

From the results of trials made early in 1874, in boring holes 35 centimetres, or 1.4 inch, in diameter, in the granitic gneiss at the north end of the tunnel, with an effective pressure of $5\frac{1}{4}$ atmospheres, the following were the depths per minute bored by the perforators of different constructors, according to official reports:

	Centimetres.		Inch.
Ferroux....................	4.01	or	1.60
McKean.....................	3.50	"	1.40
Dubois and François........	2.60	"	1.02
Sommeiller (Mont Cenis)....	2.12	"	0.85

From other observations made and officially reported, in the beginning of 1875, the following were found to be the lengths of time required by one of each system of perforator to bore a hole one metre (3.28) in depth. In these times all the delays occasioned by the changing of jumpers, machines, etc., are averaged and included:

	Total Length Driven. Metres.	Time to bore 1 m. by one machine. Machine.	Hr.	M.
Advanced gallery, north end.	6,352	Ferroux	1	9
Trench "	4,226	Dubois	1	31
Advanced gallery, south end.	2,617	"	1	24
Widening " "	623	Sommeiller	2	54
Trench "	205	McKean	2	1

It is added that the cost for repairs of the perforators working at the north end, during the three months, October–December, 1874, was, per metre of holes bored, as follows:

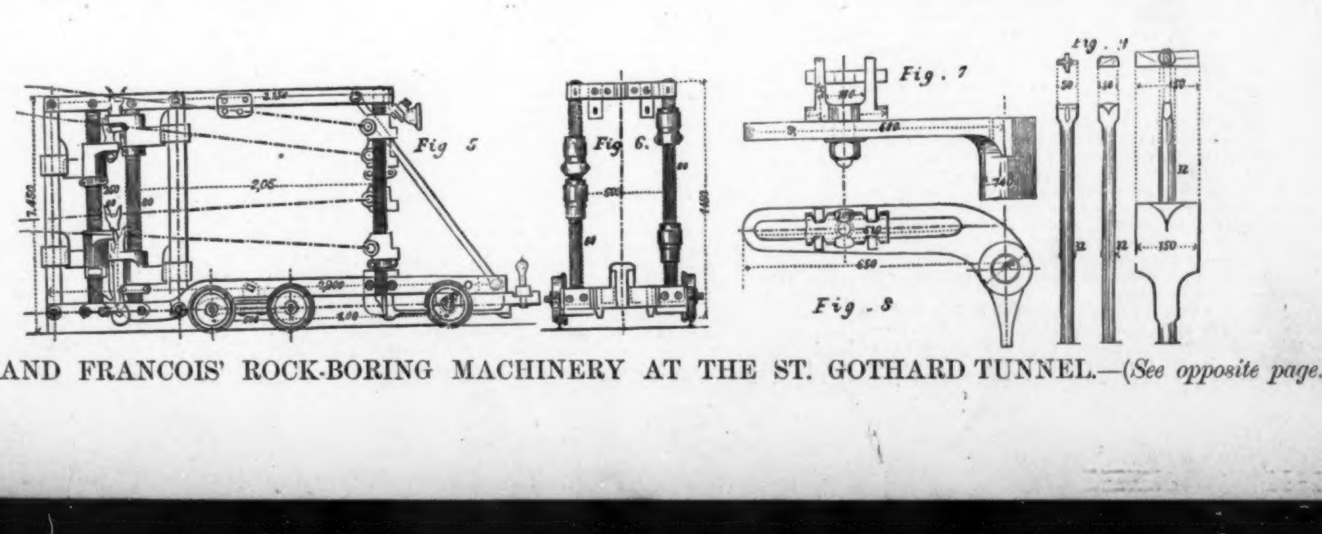
Ferroux's perforator 2.43 fr. per metre, or 1s. 9d. per yd.
Dubois' " 4.27 " " " 3s. 1d. "

In the course of the present year, 1875, considerable improvements have been made in the McKean drill, and it is stated in an official report by M. Louis Sautter that after a series of comparative trials in boring the hard granitic gneiss, the performance of the improved McKean drill proved to be decidedly superior to that of any of its competitors. M. Favre has provided himself with sixty of these drills for future operations. The body of the drill is cast of phosphor-bronze. The air-cylinder is 4 inches in diameter; the piston is of wrought iron, 2 inches thick, fitted with two pairs of Ramsbottom's rings. The piston-rod is $2\frac{1}{4}$ inches in diameter, and screwed and pinned into the piston. The maximum stroke of the piston is 5 inches; the minimum stroke is 2 inches, and the average length of stroke when at regular work is $3\frac{1}{2}$ inches. The machine can bore to a depth of 3 feet at one setting. The drill is, of course, worked by compressed air, and it is calculated that 62 cubic inches of air are used for a stroke of 4 inches. The drill can be moved with half an atmosphere of pressure, and it is capable of making from 500 to 700 strokes per minute, with air of $5\frac{1}{4}$ atmospheres of effective pressure. The total weight of the machine is 506 lbs. It is 7 feet 6 inches long, and 10 inches by 9 inches in width and depth, extreme dimensions. At the comparative trials above referred to, the drill penetrated, whilst actually at work, from 3 to 8 inches per minute, making 800 strokes; with $6\frac{1}{4}$ atmospheres of pressure, it has penetrated as much as 12 inches in a minute.

The turning movement of the drill is effected by means of a cylindrical enlargement formed on the piston-rod. Spiral grooves are cut on the face of this enlargement, which is constantly in gear with a spirally-grooved cylinder placed parallel to the piston-rod, and capable of revolving. On the return stroke of the piston, the cylinder is maintained by a ratchet motion in a fixed position, whilst the piston-rod, sliding upwards in a gear with the cylinder, is necessarily turned on its axis to a degree proportionate to the twist of the spiral and the length of the return stroke. Thus the new angular position of the jumper is secured. During the forward stroke, the spiral cylinder does not influence the piston-rod, which moves straightforward, and, on the contrary, turns the cylinder on its own axis. Nevertheless, as a precaution, the piston-rod is prevented, by a ratchet motion, from returning to its previous angular position, in making the forward stroke. On the next back stroke, the piston rod is again seized by the spiral cylinder, which is now brought up against its ratchet-detent, and is turned round as before, preparatory to making the next forward stroke.

The compressed air is supplied to and exhausted from the cylinder through a hollow cylindrical valve formed with suitable openings. For this purpose the valve receives an oscillatory movement on its axis, by means of tappets fixed on its spindle, which are moved alternately to the right and to the left on the forward and backward strokes respectively, by the enlargement on the piston-rod. The ends of the enlargement are formed conically, in order to move the tappets steadily and fairly.

The action of the enlargement on the tappets is also utilized for effecting the feed or advance of the jumper. The reciprocations of the forward tappet are communicated to a lever fixed to one of a pair of crown ratchet-wheels placed together on a screwed spindle, and held in gear with each other, like clutches, by a helical spring. The first of these, the lever-wheel, reciprocating in unison with the tappet, is loose on the spindle; but the second is feathered and engages in a longitudinal groove cut in the spindle. Thus as the second wheel



DUBOIS AND FRANCOIS' ROCK-BORING MACHINERY AT THE ST. GOTHARD TUNNEL.—(See opposite page.)

is turned, it turns the spindle with it, which, by the screw, advances the cylinder. The teeth of the first wheel slide over those of the second wheel in one direction, and engage them in the opposite direction. When, therefore, in the ordinary course of reciprocation, the first wheel is pushed round far enough by the tappet movement, it advances its hold upon the second wheel, by the interval, usually, of one tooth at a time, and, when withdrawn, it pulls round the second wheel and the screw with it, which gives the feed. Should the first wheel not be pushed round far enough by the tappet movement to gain a tooth, the teeth of the first wheel slip back into the same places and no advance is made. But the play of the tappet is increased as the stroke increases with the penetration in virtue of the conical form of the surface of the enlargement; so that, finally, when the length of the stroke has reached the maximum designed for it, the first wheel is advanced far enough to gain a tooth upon the second, turns it, and gives the feed. As there are fifteen teeth in each ratchet-wheel, each advance of one tooth is equal to a fifteenth of a revolution, and the pitch of a screw, formed with a double thread, is one inch. Consequently each advance of the feed by one tooth is just one fifteenth of an inch. By this simple combination of the double ratchet-wheel and the screw, the feed is thus minutely graduated, and the stroke of the piston, on regular work, becomes practically constant.

The McKean drill recommends itself by its simplicity, efficiency, and completeness. The whole of its functions originate in the simple enlargement of the piston-rod, from which the twisting motion, the feed motion, and the valve motion are derived.

The following are the leading particulars of the three most prominent perforators that have operated in the St. Gothard tunnel:

Perforator.	Diam. of Cylin. In.	Stroke. In.	Air consumed per Stroke. Cub. In.	Wt. Cwt.	Dimensions Ft. In. In.
Dubois	2.76	0.75 to 7.2	97.6	4.33	7.2 x 9.2 x 12.6
Ferroux	3.36	max. 6.4	140.0	4.91	10.8 x 10.4 x 14.4
McKean imp.	4.0	2 to 5	62.0	4.53	7.5 x 10.0 x 9.0

It is intended to perform the work of perforation entirely by machine, dispensing with hand labor. The area of the tunnel will be divided into seven sections: three on the upper level—the level of the floor of the heading; and four on the lower level—that is the floor of the tunnel. The culvert constitutes an eighth, and smaller section. Each of these sections, separately, will be attacked by a group of perforators, as follows:

	No. of Perforators.
The heading or *avancement*	6 to 9
The right wing of the heading, widening out or *abatage*	3 to 5
The left wing of the heading, widening out or *abatage*	3 to 5
The shallow trench in the core, or *petite cunette*	2
The deepening of the trench to the floor of the tunnel, or *grande cunette*	6 to 9
The greater mass of the core to the right of the trench, or the *strosse*	6 to 9
The narrower mass of the core to the left of the trench, or *piedroit*	3
The culvert, or *canal*	1
Total number of perforators at each end	30 to 43

The faces of the several sections will, of course, be at various distances from the front, at intervals of from 50 to 150 metres (55 to 164 yards), one behind another. By such disposition the operations on one section will not be interfered with by those of the others. From the face of the heading to the face of the excavation for the culvert—the last in succession—the interval may amount to 1000 metres (1090 yards).

LABOR EMPLOYED.

The number of men employed on the works in August, 1875, were as follows:

	Average Number.	Maximum Number.
North end	1664	1902
South end	1802	1984
Total employed	3466	3886

The composition and the duties of a shift, or "poste," of workmen at the advanced gallery, north end, in September, 1874, were as follows: One foreman, four miners, two machinists, eight laborers, one boy; in all, sixteen men at the front. Add for chargers and laborers for removing rock, twenty-two men. Total, thirty-eight men for one shift. For two shifts, seventy-six men; and for three shifts, one hundred and fourteen men.

LOCOMOTIVE POWER.

Since the month of December, 1873, a small locomotive, weighing 5½ tons, on four coupled wheels, 1 metre (3.28 feet) apart, has been employed at each end for removing the exploded rock. It was worked by compressed air, and was followed by a tender, consisting of an air-reservoir of 650 cubic feet of capacity, on two bogies. When charged at the commencement of a trip, the pressure was from 6 to 7 atmospheres. After taking a train of twelve loaded wagons, holding 1 cubic metre or 35 cubic feet each, from the tunnel to the place of unloading, a distance of about 600 yards, the pressure fell to about 4½ atmospheres; and after returning with the empty train there was left a pressure of from 2 to 2½ atmospheres.

But, in view of the considerable and increasing traffic in prospect, on a line of railway, in two long tunnels open at each end only, and which will ultimately approach to 3 miles in length, M. Favre has recently replaced these unwieldy machines by more compact and more efficient locomotives, constructed by M. M. Schneider & Co., of Creusot, and designed to be worked by compressed air of 15 atmospheres. These engines are like ordinary engines in general arrangement and detail, except with respect to the reservoir, which replaces the ordinary boiler, and consists of a cylindrical steel reservoir for the storage of compressed air. The supply of air is drawn, meantime, from the ordinary compressors at 7 atmospheres, until the special compressors in course of construction are completed, for the supply of air of the higher pressure. The air is admitted into the cylinders at a pressure of 43 lbs. per square inch. These locomotives have worked satisfactorily, and it is suggested by M. Ribourt that compressed-air locomotives may be employed with great advantage for working trains through long tunnels, in place of locomotives worked by steam, thus dismissing the unsolved problem of the artificial ventilation of tunnels.

The quantity of broken rock removed from each end of the tunnel amounts in bulk, according to M. Ribourt, to about 530 cubic yards daily; and, as each large wagon holds 1 cubic metre, or 1⅓ cubic yard, the daily traffic consists of four hundred wagons each way in the twenty-four hours. To this number is to be added forty wagons or trucks for the conveyance of building material, and ten trucks for conveying jumpers and perforating machines to and from the front. The total of this daily service represents the movement of 2300 tons daily at each end.

TEMPERATURE IN THE TUNNEL.

The temperature at the front increased slowly as the heading was extended, but it was not much affected by the depth below the surface.

The temperature of the rock was measured by inserting thermometers into holes cut to various depths. In July, 1875, at 1 foot deep, the temperature was 63° Fahr.; at 2 feet deep, 63°.55 Fahr.; at 3 feet 3 inches deep, 64°.7 Fahr.

VENTILATION OF THE TUNNEL.

The ventilators at the north end were reported in the end of June, 1875, to be nearly completed and ready for ventilating the tunnel. They act by exhaustion, on the system of the bell-exhauster. Two bells of sheet-iron, 16 feet 5 inches in diameter, with 5 feet 11 inches of stroke, are connected by an oscillating beam, from the end of which they are suspended, and on which they balance each other. They rise and fall alternately over fixed bells closed at the top with water-joints, and, when fully charged, draw about 2060 cubic feet of impure air by each double oscillation. Allowing for the partial vacuum formed within the bell, and for short measure, they should make ten double oscillations per minute to discharge 16,500 cubic feet of air per minute, which is the estimated volume of mixed air and gases to be withdrawn. The air from the interior of the tunnel is conducted through a tube, 4 feet 10 inches in diameter, placed close to the soffit of the arch, and extended inwards as far as the arching is completed. The bells are moved by water-pressure acting in cast-iron tubes fixed centrally within the bells.

It may be added, in conclusion, that the whole of the works of the St. Gothard railway are under the superintendence of Herr R. Gerwig, of Carlsruhe, who is Engineer-in-Chief of the line. The axis of the tunnel, with its length, and the difference of altitudes between the two ends, were surveyed and definitely settled by Herr Otto Gelpke, mining engineer, Berne.

NEW COMBINATION OF PROPELLERS FOR WAR SHIPS.

At a recent meeting of the Royal United Service Institution, Mr. George Quick, Engineer, R.N., H.M.S. *Tenedos*, read a paper on a "Proposed New Combination of Propellers for Ships of War."

"The objects sought to be obtained are, (1) Greater security for the propelling power and for the ship when in action. (2) Greater economy of fuel at low speed with less wear and tear of engines and boilers than at present. (3) To turn vessels quickly and in a very small circle, as well when they have no progressive motion as when moving at a high speed. To attain these objects I propose to supply additional engines for driving a turbine, or one or more centrifugal pumps for hydraulic propulsion, in such manner that when only a small speed is required, say under nine knots per hour, these engines can be used alone for propelling, and when higher speeds are required they can be used in conjunction with the screw-engines. The discharge nozzles being fitted with valves so as to allow the propelling streams from the turbine or pumps to be quickly diverted from going astern to a line at *right angles to the keel*, or right ahead, whenever it may be required either to turn quickly or to go astern. The orifices for supplying the turbine with water being fitted with valves that could be closed when required, so that in the event of injury to the ship's bottom from torpedoes or any other cause, the turbine would be able to draw its supply of water from the leakage, and by this means keep the ship afloat. Safety would be attained for the propelling power by thus dividing it into independent sections located in different parts of the ship; the different sections being used for different speeds; thus, the turbine could be used alone for speeds under seven or eight knots, the screw or screws being hoisted or placed vertically; for intermediate speeds, say over eight and under twelve knots, the screw could be used alone; whilst for speeds over twelve knots both screw and turbine could be used together. Now, it is evident that for the same maximum speed to be attained in a given ship, at least the same total amount of steam must be supplied by the boilers; and that the power of the screw engine may be reduced in proportion to the power of the additional engines supplied for hydraulic propulsion. As an illustration of the application of this principle, I give the following: Suppose a vessel is intended to have a speed of fourteen knots per hour, her nominal horse-power to be 1200, and to indicate 7200 horse-power. I propose to divide the boilers into three independent and isolated sections, one of 600 nominal horse-power, and two sections of 300 nominal horse-power each; with valves so arranged that all the boilers could be, if required, connected together, or any one section of boilers connected with any one pair of engines. By this division, the efficiency of a portion of the boiler power is rendered more secure. As regards the engines, 900 nominal horse-power, equal to 5400 indicated, would be appropriated for the screw propeller or propellers, and 300 nominal, equal to 1800 indicated, horse-power for the hydraulic propelling engines. Now, if a similar ship, fitted only with a screw in the usual manner, has been propelled fourteen knots per hour with 7200 indicated horse-power, the speed of the proposed ship with screw engines indicating 5400 horse-power, will be 12·6 knots per hour, that is calculating according to the approximate rule that the speed varies as the cube root of the power. With the hydraulic engines alone working at 1800 indicated horse-power, the speed of the vessel will be 8·8 knots per hour. Or if these hydraulic engines are used at half power, = 900 indicated horse-power, the speed will be 6·9 knots, say seven knots per hour. It is evident that as hydraulic propulsion hitherto has not proved quite so efficient as screw propulsion, the extreme maximum speed attained by using the two together at the same time may not be quite so great as by the single screw using the same amount of power, but the enormous advantage of security to the propelling power and the ship, with rapidity or turning in action, *especially for ramming*, far outweighs a slight loss of extreme maximum speed, if any such loss should be experienced. In short, by the proposed combination of hydraulic and screw propulsion, all the advantages of both systems may be obtained in one vessel without the disadvantages attending on the use of either separately. In proposing the preceding division of steam power between the turbine and screw, I have considered that the former engines should be sufficiently powerful to enable the vessel to remain in action, by being capable of moving at an effective fighting speed, even if the screw-engines should be entirely disabled; and I have estimated that eight and a half knots per hour would be sufficient for that purpose. But the proportion of turbine to screw-power may be very different from the foregoing, so as to suit the construction of the vessel or the service for which she may be specially designed. It is obvious that we can not demand unlimited space and choice of location for our engines, but must make the best use of that which is assigned to us.

"Applying this principle to a well-known vessel, Her Majesty's ship *Devastation*, of 800 nominal horse-power, and taking the results of her trial trip as data, namely, speed 13·8 knots per hour, indicated horse-power 6630, the following speeds would be attained by the turbine and screw respectively: Turbine engines 200 nominal horse-power, speed by ditto, 8·6 knots per hour. Screw engines 600 nominal horse-power, speed by ditto, 12·55 knots per hour. If, however, the hydraulic propelling engines be of 100 nominal horse-power only, the screw engines being of 700 nominal horse-power, we get a speed of 6·9 knots by the turbine, and 13·21 knots per hour by the screw engines alone. The speed in each case with the combined propellers being 13·8 knots per hour nearly. But if the screw engines remained as at present, and room could be found for a pair of engines and turbine of only 50 nominal horse-power, the speed by these small engines alone would be 5·47 knots per hour; whilst the efficiency and safety of this vessel as a fighting machine would be much increased by the facility afforded for turning in ramming and torpedo attacks. In lieu of one pair of engines working a single turbine of great capacity, it would be possible and in some cases desirable, to use two or more sets of independent engines and turbines of small power, and separated by water-tight bulkheads. But this is a matter which would be determined by the proportions and nature of the ship. Again, by the adoption of the auxiliary hydraulic propeller, a single screw may, in some cases, be used advantageously in lieu of twin screws, by which considerable economy of space would be effected, and the coal-bunker capacity increased.

"From the foregoing it can be seen that the turbine may be applied as an auxiliary propeller in three different ways: (1) as a powerful auxiliary to the screw, capable of maintaining a ship in action after the screw engines are disabled; (2) as a feeble auxiliary, occupying little space, but sufficiently powerful to drive a mastless or other vessel for very long distances at low speed, which speed would not be sufficient for fleet actions or for heading against a gale of wind; (3) in very large vessels of the *Inflexible* type, whilst considerable turbine power may be supplied for propulsion, and located so as to exert its maximum efficiency for that duty, a small turbine may be supplied and placed in the best position to enable it to perform the special duty of quickly turning the vessel and also for acting as a bilge-pump and fire-engine. I anticipate great economy of fuel to arise from the use of the turbine engines alone, when a low speed only is required; the economy resulting from the use of small engines working at nearly full power, instead of using screw engines of great weight, frictional resistance, and large heat radiating surfaces at very low power. Having had occasion to study the effect of the reaction of streams of fluid for a special purpose, I have arrived at the conclusion that for vessels of very fine lines the turbine may be used for the sole propeller as efficiently as the screw, provided it be properly proportioned, and constructed to suit the vessel and speed for which it is intended. The great point to be considered with regard to *full-powered* turbine propulsion is this, whether with a given cubic capacity, weight of machinery and coal consumption, the turbine can propel a vessel at as great a maximum speed as the screw propeller can. If it can, then the turbine will rival the screw as a sole propeller. If, on the other hand, the turbine could be made, with the same bulk and weight of machinery, to give a greater maximum speed with the same economy of fuel as the screw, then it would totally eclipse the latter. On this question it is well to observe, that whereas thousands of screw propellers have been made and tried, and are now fitted so as to be capable of being altered in pitch to suit the vessels to which they belong, only a very few experiments have been made with hydraulic propulsion, and none at all, that I am aware of, of an exhaustive nature, involving altering of the machinery. But if we can only make the turbine within certain limits to approach the screw, for speed and economy, then it may be used with advantage as an auxiliary propeller, in consequence of its capability of performing most important duties, other than propelling, which the screw can not be made to do. I have thus briefly stated my proposal for your consideration as Combatant Officers, for I venture to look upon it as your province to say whether auxiliary hydraulic propulsion should be used; and if so, in what proportion to the screw, and for what purpose; and the Engineer Officer's duty to be to design the most powerful and compact machinery to occupy the space and location the Naval Constructor may provide for it. In conclusion, I may state that I have designed means to obviate certain defects and difficulties which have been hitherto experienced in the application of hydraulic propulsion, and which have retarded its extension. These means being, however, a matter of mere mechanical detail, I do not ask you to condescend to consider them, but the important general question as to the desirability, or otherwise, of using hydraulic propulsion as an auxiliary to the screw in large vessels of war."

[Engineer.]

MARINE PROPULSION.

It is a remarkable fact that the theory of marine propulsion has been suffered to remain for nearly half a century in an unsatisfactory condition in certain respects. In spite of the enormous sums which are annually expended on the construction and working of steamships, shipowners and engineers have alike rested content with the assumption that given conditions of form and relations of power to speed and displacement being satisfied, nothing better in the way of an economical result of the application of steam-power to the propulsion of ships could be obtained. This is equally true of paddles and screw. Few attempts have been made to determine conclusively, by actual experiment, how much of the power of an engine must of necessity be wasted in forcing a ship through the water. The most that has been done is to calculate the useful horse-power by the thrust of a propeller shaft, and then dividing this by the indicated horse-power, obtaining a fractional exponent of network performed; and all this time we have been content to go on changing the forms of screw-propellers, and altering the shape and dimensions of paddle-wheels, without much intelligent perception of the reason why one shape should be better than another. The unsatisfactory condition of the theory of propulsion has, however, long been known to a few individuals who are not content to accept statements as being accurate in the absence of proof. Mr. Froude, by his laborious investigations, is doing a great deal to reduce problems of fluid resistance to a proper shape. The old notion, that this resistance varies as the cube of the speed under all kinds of conditions, bids fair to be totally dis-

placed; and if Mr. Froude can only succeed in dealing as successfully with eddies as he has done with skin friction, we may expect that important advances will be made in the art of designing ships of least resistance. Mr. Aston has recently obtained results—to which we have already referred—with paddle-wheels, which are alike remarkable and unexpected, and Mr. Griffiths has apparently succeeded in proving that by paying proper attention to the mode in which screws are applied to the propulsion of ships, an enormous saving in power may be effected without any loss of speed.

The propulsion of a ship by either paddles or screw depends on totally different conditions from those determining the motion of a locomotive-engine on the rails. These last constitute a fixed fulcrum for the driving wheels to operate against; and the tractive effort of a locomotive on the train behind it is—neglecting the resistance of the engine itself—precisely similar in amount to another force tending to push the rails backwards. If the train were held by an anchor and the rails were free to move, they would recede, and the work done by the engine would be the same in either case. The tractive effort exerted on the train, multiplied by the velocity, would give us the horse-power exerted by the locomotive minus friction. In a word, there is no necessary waste of power, expended in performing useless work, in the action of a locomotive. The case supplied by the engines of a steamship has nothing in common with that of a locomotive. The propulsion of the vessel depends solely on the resistance offered by a given weight of water to being put in motion. A very simple formula for determining the thrust of a propeller or paddle shaft has been proposed by Mr. Richard Boyman, several years since, and this formula was accepted by the late Professor Rankine as substantially correct. It is $T = \frac{W\,v}{g}$; where T is the thrust in pounds; W, the weight in pounds of water moved astern in one second by the propeller; and v is the velocity in feet per second imparted to it. It matters nothing whether the velocity is imparted in successive steps or all at once. It is the final velocity at the moment of leaving the face of a paddle-board or a screw with which we have to do. Let us suppose, for example, that 1000 lb. of water per second are moved astern at the rate of 30 ft. per second by a screw-propeller; the thrust of the shaft will then be $\frac{1000 \times 30}{32{\cdot}2} = 931{\cdot}7$, or in round numbers, 932 lb. If the screw-shaft moves ahead as fast as the water moves astern, the horse-power returned by this thrust will obviously be $\frac{932 \times 60 \times 30}{33{,}000} = 50{\cdot}8$. This, then, represents the absolute or useful work obtained from the engine. Let us see at what cost this is got.

The water put in motion astern does no useful work whatever. The motion imparted to it—its potential energy at the moment of leaving the propeller—is dissipated and expended on the masses of water still at rest, with which it comes into contact, and is ultimately converted into heat in a way too well understood no doubt to require explanation at our hands. It is very easy to determine what the potential energy of the water is by the well-known formula $\frac{W\,v^2}{2g}$. Each 1000 lb. of water passed through the propeller per second is found to represent $\frac{1000 \times 900}{64{\cdot}4} = 13{,}975$ foot pounds nearly. In other words, the work expended in driving 1000 lb. of water astern would have raised it to a height of 13·975 feet in a second, or it would have raised 60,000 lb. of water to the same height in a minute. In round numbers this represents 25-horse-power, and it follows that to obtain a thrust of 932 lb. under the conditions, we must employ an engine of 75·8 horse-power, whereas, if the fulcrum had been fixed instead of movable, we should have needed but 50·8-horse power; in other words, one third of the power is wasted by the mode of action of the propeller, to say nothing of that lost in overcoming the friction of the machinery. We have assumed so far that the propeller is moving the water astern in one direction as fast as it is moving itself in the other. But a little thought will suffice to show that this assumption is based on no necessary condition. In theory the propeller in moving forward finds the water at rest, and any molecule of water which is left at rest would obviously have played no part in the work of propulsion. In order that the water may be put into motion at an absolute velocity of 30 feet per second, it must pass away from the propeller at the relative velocity of 60 feet per second, because the propeller is retreating from the receding particles of water at the same velocity that they recede. But the actual work done per thousand pounds of water repelled will remain unaltered. So long as the absolute velocity of the retreating water is unchanged, the speed of the ship will in no wise affect the thrust of the propeller. In practice, of course, conditions come in which modify results, such, for example, as the power of the engine, which may not be sufficient to keep up the velocity of the propeller to the required point, when of course the thrust would be affected by the velocity of the ship; but with these conditions we have just now nothing to do. It is not necessarily true that the shaft must move ahead at the same velocity as the water is heaved astern; so long as the latter factor remains unchanged, the speed of the ship may vary through enormous ranges without affecting the thrust, which is determined solely by the weight of water put in motion sternwards and its velocity; of course if the weight or velocity is modified, the thrust will also be modified, but not else. It will be seen, therefore, that a bluff, heavy ship, moving at a slow speed, may waste more power than a sharper ship going at a higher velocity. For example, let us suppose that in the calculations we have used the speed of the screw-shaft, and with it that of the hull, was but 15 feet per second instead of 30 feet, then the power expended usefully on the ship would be 25 horses only, while that driving the water astern uselessly would remain unchanged at 25-horse power, and the total power expended would be 50-horse power instead of 75, and the loss would reach 50 per cent.

We have said nothing up to the present of the influence exerted on the supply of water to the screw by the speed of the ship; nor is it necessary for our present purpose that we should. Our object has been to demonstrate that under all circumstances a certain proportion of the power exerted by the engines must be wasted in doing ultimately useless work upon the water. We have shown that there is no invariable relation between the speed of a ship and the speed at which water is driven astern; yet it is certain that some relation exists which is better than any other. This may be expressed in a different way by stating that, with a given propeller in a given hull, there is some velocity, at which that propeller can be driven which will give better results than any other velocity in the sense that the power wasted in sending the water astern will bear at that speed the smallest proportion possible under the conditions to that exerted in driving the ship through the water. Now, this is just the point where the whole theory of propulsion has hitherto broken down. There is no such thing as a satisfactory and universally applicable formula for solving this problem, and it is even doubtful whether a satisfactory solution will ever be attained; and one reason is that very little indeed is known as to the actual weight of water which any given screw can send astern in a given time. It appears tolerably certain from Mr. Griffiths's experiments that if screws could only get water enough they could deal with much greater quantities than they have the chance of obtaining in the ordinary way. The whole question is far too complex to admit of being handled in a single brief article, and we hope to return to the subject. If we have succeeded in convincing any of our readers before unconvinced, that much power must unavoidably be wasted by any conceivable form of marine propeller, and that the most that can be done by the cleverest engineers or shipbuilders is to reduce that waste, our present purpose is answered.

CONDENSED BEER.

By Dr. BARTLETT.

THE apparatus employed consists of a copper vacuum-pan, with which is connected a condensing worm of solid tin, immersed in a tank of water. Two copper globes are attached for the collection of alcohol.

A certain quantity of beer being drawn into the vacuum-pan by a few strokes of the pump, the two under-taps are closed, and the steam permitted to enter the jacket which surrounds the pan, and the air-pumps are then carefully tended so as to maintain a vacuum of 25 or 26 inches pressure, and a temperature of from 130° to 160° during the first portion of the process. Some little attention is then necessary to work at the best advantage, but in a short space of time the whole of the alcohol comes over, and flows into the lower globe, the connection between which and the upper is then closed. By this means the alcohol can be collected without either breaking the vacuum or stopping the air-pump.

When it is found that the whole of the alcohol has come over, it is removed in a proper stoppered vessel, and is found to contain all of the delicate volatile flavors of the beer. As soon as the spirit is all removed, the operation of condensing is then assimilated to that of condensing milk, and consists simply in the removal of water to whatever degree may be considered desirable, and in practice the beer is thereby reduced to a thick semi-fluid state, after which it is drawn off from the pan.

A barrel of beer, containing 36 gallons, is in this manner concentrated into a bulk of little over two gallons, and there is besides an average of more than two gallons of alcohol of proof strength. The thick fluid extract consists of all the solid matters held in solution by the original beer, together with a small proportion of water, which is purposely retained to keep these matters fluid, so as not to change in the slightest degree the natural constituents of beer as they would inevitably occur if the condensing process were carried so far as to reduce the extract into a solid state. Following, in this instance, the experience derived from the practical condensing of milk, in which it is found that if the milk is absolutely dried, it is with difficulty re-dissolved, and never regains the whole of its former properties; so with the beer extract, we have ascertained that the fluid or semi-fluid condition into which it is reduced by Mr. Lockwood's processes, enables the remixing with the proper proportion of water to be effected with the greatest possible ease, while the peculiarities of each kind of beer are distinctly reproduced without the alteration which reproduction from a solid extract always entails.

When the condensed extract is taken from the vacuum-pan and cooled, the alcohol is remixed with it. In practice this has been found to be desirable, but it is by no means necessary, as the thick fluid extract of beer will keep by itself even if left in an open jar for nearly two years. I have a specimen, which has remained exposed to the air since the latter end of March, 1874. It can be put up in tin cans, similar to those used for condensed milk, but we prefer to remix the alcohol with the extractive matters, rather than export it separately, because it enables us to clear the solution, by rendering it much more fluid. We have then a solution of all the extracts of malt and hops which were contained in the beer before condensing; we have the whole of the salts of the Burton waters, if the beer has been brewed in that district—all the aromas and volatile matters which, having been carried over with the alcohol, are retained in it, and returned in remixing with the extract. Every valuable constituent of the original beer is there present, minus only nine tenths of the water. And if it were needed to prove how permanently unchangeable the condition of the finished condensed beer must be, I need only call attention to the fact that the extractives are dissolved in spirits of the strength of brandy, and that the temperature to which the beer has been subjected during the process of condensing is such that without being sufficient to injure or alter the character of the beer when re-made, in the slightest degree, yet is high enough to render inert all the fermentive germs, so long as the beer is kept in its concentrated form.

A barrel of beer is so reduced in bulk that it can be contained in cheap cases of wood lined with tin, the exterior dimensions of which are somewhat less than a cubic foot. Now, as freight is charged by what is termed barrel bulk, in which a beer-barrel is generally reckoned as nine cubic feet, it is evident that a saving of eight ninths of the total freight in shipping beers is saved by this means.

When it is desired to remake the beer, all that is required is to empty one of these tin cases, and make it up to the thirty-six gallons by the addition of water. Beer is at once produced substantially identical in strength and flavor with that before treatment. But when remixed with its proportion of water, the beer is necessarily without briskness. The constituents are all there, the flavors are still retained, but I doubt whether it would be recognized in this condition as being exactly the beer we are accustomed to. It must be distinctly understood that beer received from the brewery continues to develop a very minute portion of alcohol from the saccharine matters, and in this process gives off a certain amount of carbonic acid gas. Before this gas is thrown off from the beer in the form of froth, the liquid becomes completely saturated with this gas, and unless the beer is so saturated with carbonic acid, it cannot possess one of its most distinctive flavors; without which, in fact, beer would not be considered drinkable.

In the process of condensing, we have driven out the whole of the carbonic acid gas, and we have now to restore its full equivalent. In dealing with this most important stage of the reproduction of the beer, I have had the advantage of the practical experience of Mr. Southby, whose intimate knowledge of all the processes of brewing has been acquired as chemist and brewer to Messrs. Allsopp & Sons, and in other breweries, and I may say his assistance has been invaluable. Treating the remade beer as we should any other beer, which being quite sound has been "flattened" for bottling, as is always done, we soon found that the suggestion made by Mr. Lockwood of merely adding a little uncondensed beer in its original condition is all that is required to stimulate the reproduction of carbonic acid gas to any extent that may be wished for, but a very rapid development of the gas may be given by a little yeast. Take a tin of condensed stout and make up 36 gallons, by the addition of water and a little stout which has never been condensed, an excellent stout will be produced equal in all respects to the original beer.

If the particular stout was that of Guinness, or of Messrs. Reid, or Barclay and Perkins, the distinctive peculiarities of each of these separate brews will be as marked and easily recognizable as before they were condensed. The same may be said with regard to ales, Burton ales being clearly distinguishable from those brewed with soft water.

The development of carbonic acid can be controlled by temperature to a considerable extent, and if it is desired to get the remade beer into condition rapidly, a higher temperature will greatly accelerate the result when no yeast is procurable, and it is for this reason that we prefer reproducing the aëration by the addition of fresh beer.

During the experience of the last six months, we have condensed considerable quantities of different kinds of beer, with what we deem a gratifying success. During the same period, we, though but inexperienced bottlers, have bottled many grosses of these different beers. When the skill and experience which has to be devoted to the bottling branch of the beer trade is taken into account, and the inherent difficulties of dealing with comparatively small quantities at a time, we think that we have reason to be more than satisfied with what we have done.

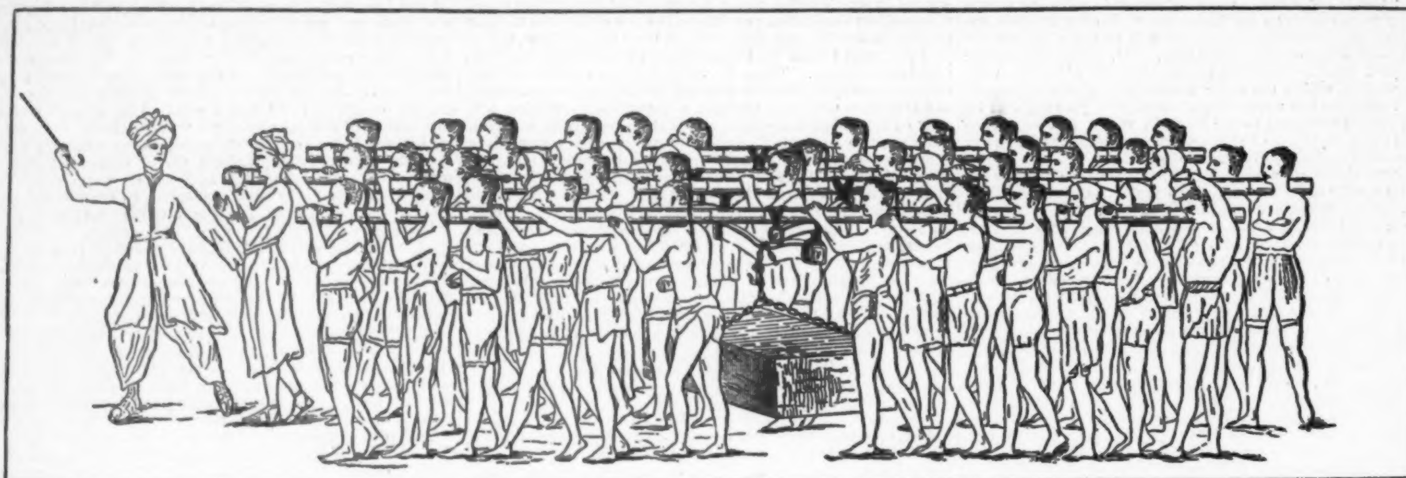
We have noticed that by using a small quantity of extract and larger proportion of water, thinner beers, and of less alcoholic strength, can be reproduced of as sound a quality as the strongest. Such a beer is undoubtedly the most fit for use in tropical climates. On all hands, it is agreed, both by the medical profession and those who consult them, that if a thin, light, and pleasant beer could be obtained in hot countries, much of the recourse to the brandy-bottle would be averted. Beer is what is desired; the beer at present procurable in those regions, as previously stated, is a very strong or very expensive bitter beer. The consequence is that such beer is only to be drunk in small quantities, and hence the very small exportation of beer that I have alluded to. If, instead of brandy pawnee, gin slings, cocktails, juleps, and a variety of other ingeniously deleterious mixtures of strong alcohol and bad soda-water, good, sound, and pleasant beer can be cheaply sold, in which the alcoholicity is reduced to the most moderate proportions, I have little doubt but that the export of beer from this country will assume dimensions somewhat nearly related to that of its home consumption.

It now only remains for me to discuss the question of cost involved in the process of condensing beer, and as this is one of the greatest practical importance, I will ask you to grant me your indulgence while I pass rapidly over the items. In the first place, the cost of the beer-barrel here is about 25s.; abroad they are generally of so little use that the odd five shillings may be considered as beyond their average value. Against this must be placed the cost of two shillings for the tin-lined case which holds the equivalent of the barrel of beer when condensed. Here is a saving of at least 18s. per barrel, that of the freight is at least seven eighths, besides obviating the risks of transporting beer in casks, which are so great as to add at least from 10 to 15 per cent to the other costs incurred, but more generally it is found necessary to make a much larger allowance for ullage, and beer which becomes sour. Not unfrequently whole cargoes are discharged from the ship, perfectly worthless from the latter cause, a risk which the process of condensing entirely obviates. The cost of a barrel of beer being roughly taken at 60s., the saving effected so far would be equal to some 25s., exclusive of the cheaper freight. But when it is remembered that beer is exported in bottles to many countries, and the bottles are inclosed in casks, the whole occupying at least double the amount of room which it would in a barrel, a far greater saving is effected. In addition to this, the re-bottling of condensed beer in many countries can be accomplished at an almost nominal cost, bottles having become so superabundant as to be readily procurable at 3s. a gross, the price quoted in London being 22s.

Beyond the great economy so effected must be mentioned the still greater saving when the beer is required to be transmitted to inland stations. Against the savings which have been enumerated, the only additional expense incurred is the cost of condensing and remaking it. The most careful estimates have been made, deduced not only from the extended experiments which have been carried out by permission of the Commissioners of Inland Revenue, but also from data furnished by the experiments conducted at the Condensed Milk Company's Works. We have the assurance that the total expense attending the process of condensing can not exceed the sum of 2s. per barrel, and that of remaking about twice that sum.

A MODEL PATENT-OFFICE.

THE Paris correspondent of the New-York *Times* is responsible for the following story, which he says came to him from Vienna, but does not say by what channel: "In the Austrian Ministry of Commerce there is a department corresponding with our Patent-Office, where inventors send models and samples when applying for patents. These are not always examined with a promptness that the inventors desire. Under the impression of the Mosel explosion, everybody began to talk of dynamite, picrate of potassa, and nitroglycerine, the learned employees relating many stories to show the danger of these powerful explosives and the fatal effects produced by them. When one clerk was relating something that he had read upon the subject, another cried, 'Why, we have several boxes here labelled dynamite.' Half the clerks in the room sprang from their seats at once, and some rushed for the door, but when quiet was restored it was resolved to examine the packages. Four boxes of dynamite were found that had been sent in April 11th, 1874, and all this time the clerks had been working on quietly beside annihilation without knowing it. The boxes were carefully tied up and sealed with red wax, and no one had touched them since they were first sent in, nor had the specifications accompanying them yet been reached. When the discovery was made the clerks had no more stomach for work. It was impossible to induce them to remain in the building, and not knowing what to do with the dangerous boxes, a man who was ignorant of their contents was employed to take them to the Police Station. It was only when the last box had left the building that the frightened clerks returned to their stools."



THE KHALIAUT COOLIES OF INDIA.

THE KHALIAUTS OF INDIA.

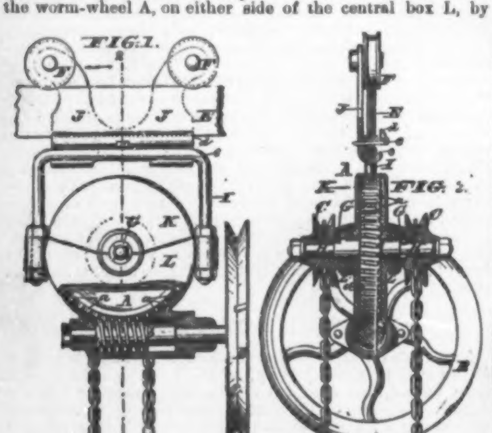
IN the province of Mysore, Southern India, there are a number of men who are now becoming disorganized for want of attention on the part of the local government. They are raised in companies of a hundred, each company being divided into twenties; each twenty have a Duffadar, while the whole company have a head man or Jemadar. These men, called "Khaliauts," are not like the ordinary coolie; they work and mean work; they have an *esprit de corps*; they are chosen men, well formed, strong, and vigorous, and by proper management can be worked almost as well as English workmen—nay, in these times of independent feeling and strikes, it may not be too much to assert that they may be made to work as well and with a far better spirit. The illustration gives a representation of two gangs of Khaliauts—about forty-four—engaged in conveying a large cut stone from the quarry to the intended works. The Jemadar is generally of the Brahmin caste, and therefore physical labor to him is objectionable in the extreme; his duties consist in giving directions. The Duffadar, on the contrary, is a lower-caste man, and does not disdain to put a shoulder to the wheel at times.

The engraving shows the method of conveying large and costly cut stones from the quarry to the site of the dam by Khaliaut coolies by means of slings and bamboos. The stone being 5 ft. × 2 ft. 9 in. × 1 ft. 3 in. = 17.18 cubic feet = 2577 lb., or 1 ton 3 cwt. total weight. The stone was supported by forty-eight men, each man sustained a weight of 54 lb., or nearly half a hundredweight. A little consideration will, however, show that undue weights are given from one to another in the course of transit. The distance from the quarry to the dam was about three miles, and the time occupied in going there and bringing the stone was a day. The men were paid at the following rates: Jemadar, or head man, per diem 7 annas, or 21 cents; Duffadar, or second man, per diem, 5 annas, or 15 cents; Khaliauts, number, forty-four, 4 annas, or 12 cents, each—176 annas; total, 188 annas, $5.64.

NEW HOISTING APPARATUS.

By L. T. PYOTT, Philadelphia, Pa.

A, WORM-WHEEL, having its bearings in a central box, L. B is the driving-wheel, having on the inner end of its axle a worm or screw, *b*, which, meshing into teeth *a* on the wheel A, rotates the same on being revolved. C C are the chain-wheels or sheaves, which are placed in direct attachment with the worm-wheel A, on either side of the central box L, by



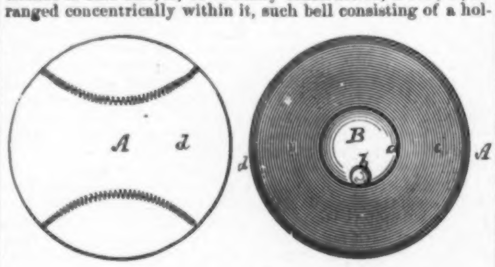
NEW HOISTING APPARATUS.

means of clutches G and bolt H, thus dispensing with the use of either shaft or keys. D D is the double chain, to one end of which is secured, by any suitable means, a hook, to which articles to be hoisted are attached. The other end of the chain is carried over the wheels or sheaves C, which, on being revolved by turning the wheel A to the right hand, draw the chain and load thereon up, and allow the other or free end of the chain to fall toward the ground. A reversal of the motion causes the hook end of the chain to descend, as will be well understood. E represents a rail, from which the hoist may be suspended. F represents grooved wheels, which, when the apparatus is to be used as a traversing-hoist, enables the same to traverse from one point to another of the rail. I represents a yoke, which is firmly secured at its ends, by nuts, to projections on the box L of wheel A. K represents an inclosing-cover. A hanger, J, has at one end suitable grooved wheels F, which, fitting the top of the rail, enables the apparatus to traverse from one end to the other. A groove, *d*, formed near the other end of the hanger, receives the lower side of the rail. Below this groove is a second groove, *e*, of hook shape, upon which the yoke I is hung. A wedge, *c*, is inserted between the lower portion of the upper groove and the top of the hanger I, for the purpose of holding them firmly together and preventing shaking.

IMPROVEMENT IN BASE-BALLS.

By S. HIPKISS, Boston, Mass.

IN the game of "base" it is occasionally very difficult, if not impossible, to ascertain whether the ball is struck by the bat, the blow being so light, or so aslant on the ball, as to prevent the blow from being heard. I combine, with a cricket or base-ball, A, of ordinary construction, a bell, B, arranged concentrically within it, such bell consisting of a hol-



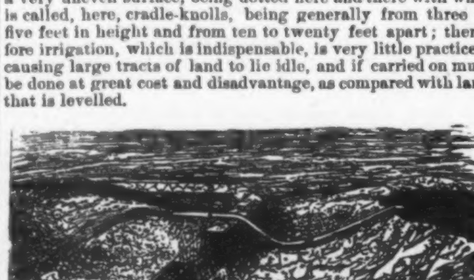
NEW BASE-BALL.

low sphere, *a*, of metal or other suitable material, furnished with a clapper or one or more small balls, *b*. This bell or alarm apparatus, besides constituting a load or heart piece to the ball, is to indicate whenever it is struck by a bat in the hands of a player. The body *c*, of yarn, is to be wound directly upon the bell, the cover *d* being subsequently applied in the usual way to such body

PROCESS FOR LEVELLING LAND.

By T. R. LOWE, Centerville, Cal.

MUCH of our agricultural land is plain or prairie land, with a very uneven surface, being dotted here and there with what is called, here, cradle-knolls, being generally from three to five feet in height and from ten to twenty feet apart; therefore irrigation, which is indispensable, is very little practiced, causing large tracts of land to lie idle, and if carried on must be done at great cost and disadvantage, as compared with land that is levelled.



LEVELLING LAND.

One of the worst features of the present mode of irrigating is, that the laborers are compelled to work most of the time in the mud and water, with the thermometer oftentimes at 110° Fahrenheit in the shade, said labor being not only extremely unhealthy, but also unpleasant and unsatisfactory, as it is impossible to irrigate rough and uneven land so thoroughly as level land—for instance, on the former the water often standing so long on the low places as to injure the crops, and causing malaria, while the higher portions receive little or no benefit of the water.

My invention contemplates reducing this kind of land to a level by means of a stream of water forced against the knolls or higher portions of the land, as hereinafter described, so as to wash it into the hollows, and thus produce a level surface of what was before knolly and uneven.

I conduct the water through suitable pipes or hose *a* to the point where it is to be used for levelling the land. I then throw up levees B, wherever it may be necessary, around the tract of land desired to be levelled, and at intervals in said levees I put in boxes C and stationary gates D within said boxes, said gates to be as high as the desired level to be attained by the land. I then apply a stream of water from the hose or pipe against the higher portion of the land or knolls by means of water-pressure, or by means of engines, force-pumps, or other machinery, until the knolls or higher portions of the land are reduced to the consistency of thin mud. I then turn suddenly into this mud a large stream of water, so as to force it into the lower land or hollows, and thus bring the entire surface to a uniform level.

THE STEAM-YACHT ARGO.

THE large new screw steam-yacht Argo recently sailed from the Mersey, upon a scientific cruise to the West-India Islands, the adjacent district embracing the mainland from Demerara to Vera Cruz. The Argo is the property of Mr. Alfred and Mr. Philip H. Holt, of Liverpool, who, not being able to leave business this winter, chartered her for four months, through Mr. St. Clare Byrne, to Mr. Reginald Cholmondeley, of Condover Hall. The Argo is not quite an orthodox yacht, but a hybrid, a cross between a yacht and a merchant steamer. The object for which she was built was that her owners might visit distant parts of the world, traversing the stretches of ocean at such a speed as not to render the transit tiresome; while her size, strength, power, and style of construction, are expected to render her as comfortable and safe a conveyance as an ordinary mail-steamer of any of the usual ocean lines. The immediate aim of the present cruise is natural history, and visits to remote places of interest which are generally inaccessible, or only to be got at with great discomfort. As a steam-yacht, the Argo may by some be thought wanting in style, but she is probably the only one afloat which could undertake a voyage round the world, maintaining high speed all the way, without her coal expenditure depleting a Crœsus. She is emphatically a steamer, not a sailing vessel, having only two handsome pole-masts and small canvas; her stem is straight, and her stern a very neat, light, round one. The following are her leading particulars: Length aloft, 207 ft. 6 in.; breadth, 26 ft. 3 in.; and depth, 16 ft. Tonnage O. M., 706; tonnage, gross register, 580; net tonnage, 395; and Royal Thames measure, 660. Her engines are of compound surface, condensing description and are a very pretty, complete, and well-finished job; there are four cylinders, two being 16 in. and two being 32 in. in diameter, with a stroke of 3 ft. On the measured mile trials she ran just twelve knots, with an indicated 649 horse-power. Her capacity for coal is unusually large, she having gone to sea with no less than 594 tons on board, which amount it is expected will be sufficient for the entire cruise, as she will only burn about nine tons per day. Her owners' accommodation is arranged abaft the engines, under a slightly-raised quarter-deck; the dining-saloon is a very neatly-fitted room, about 25 ft. by 13 ft. There are about ten state-rooms, with pantry, baths, store-rooms, etc., the cooking being done in a good galley on deck amidships. Her officers are in a fine deck-house forward, where there is a capital mess-room, and the crew are forward. There is a handsome deck-saloon on the quarter-deck. The Argo is on the register of the Royal Mersey and Royal Welsh Yacht Clubs, and at present is the largest screw steam-yacht afloat, and she has a crew of thirty-three all told; she was built and engined by Messrs. Scott & Co., of Greenock.—*Land and Water.*

STEAM LIFE-BOAT.

THIS boat, propelled by steam power, the invention of Mr. Atkin, has a rudder at each end, and each rudder rotates on its own axis, and is connected with a steering apparatus situated in the centre of the boat. The boat is of the tubular type, being formed of three tubes or oblong cylinders, and decked over. She is so ballasted and constructed that her inventor claims her to be non-capsizable. The screw-propellers, two in number, are situated in the middle of the boat, and are therefore always immersed even in the roughest seas. Thus the objection to screw-propellers in small boats differently constructed is overcome. Mr. Atkin does not recommend his boat for universal use, but in such localities as the Mersey, Harwich, Ramsgate, Yarmouth, etc., where shoals abound, he thinks it would prove invaluable. The difficulty of propelling boats of any form through broken water, and against strong winds, by the use of oars, is so great as to often prove insurmountable; and shallow-drafted boats, such as must be used where shoals exist, are not possessed of sufficient lateral resistance to be weatherly, so that steam-power is an absolute necessity in certain localities.